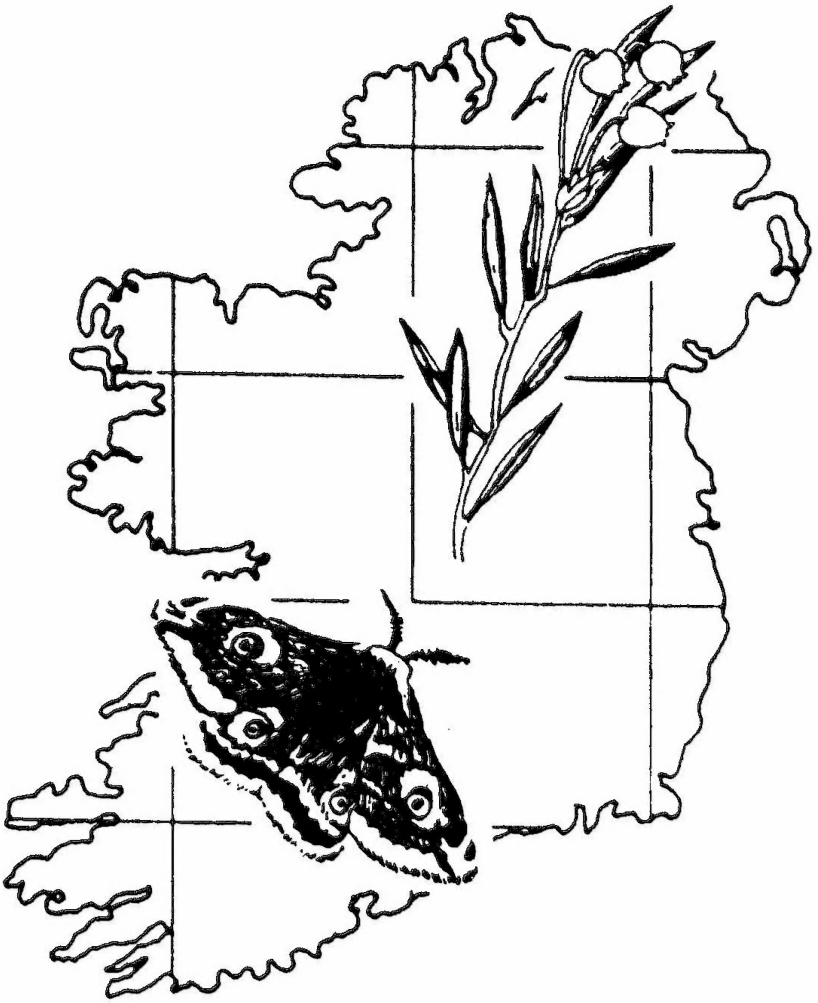
IRISH BIOGEOGRAPHICAL SOCIETY



Bulletin No. 33

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Number 33

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EDITORIAL

As the Irish Biogeographical Society publishes its thirty-third *Bulletin*, its finances have been affected by the economic downturn. This year, some of our sponsors have had to either reduce their sponsorship or postpone their funding. However, unlike some other voluntary bodies, we have been fortunate that our reserves were retained in current and deposit accounts. They remain available therefore to support the work of the Society. In addition, the size of the *Bulletin* has been reduced since 2008 in order to reduce printing and postal costs. As a result, it will not be necessary to raise the subscription rate in 2010.

Sadly this year, our printers Fodhla went into voluntary liquidation after being existence for some eighty-four years. They provided an excellent service to the Society and we are very grateful to their staff for their very many kindnesses. Happily, Mr Jim Carwood, who supervised the production of our publications in the firm, has been our liaison with the new printers.

This year, the Committee was privileged to appoint Mr Pat O'Sullivan as an Honorary Member of the Society. He is only the fourth member to be so honoured. Pat worked in the National Museum of Ireland as the Senior Technical Assistant of the Natural History Division. In that position, he had *inter alia* a wonderful ability to look after scientific and other visitors and was a marvellous ambassador for the institution. After his retirement, he continued his long-time support for the Society and has made very generous contributions to the Society's finances in both 2007 and 2008.

Bulletin **No. 33** contains an excellent mix of articles and we are very grateful to our contributors for their papers. On behalf of the Committee, I also wish to thank Dr Pat Wallace, Director of the National Museum of Ireland, for his continued support, our sponsors for their financial contributions and our referees for the thoroughness of their reports.

J. P. O'Connor

Editor

28 August 2009

INSTRUCTIONS TO CONTRIBUTORS

1. Manuscripts should follow the format of articles in this *Bulletin*. The titles of journals should be given in full in the references.

2. Manuscripts should be submitted as typed copy on A4 paper, using double-spacing and 2.5cm (one inch) margins. Whenever possible, also submit the text on diskette. **Word is preferred and Times New Roman 13pt should be used.**

3. Figures and tables should be submitted in a size suitable for reduction to A5 without loss of detail. It is important that the text should remain legible after reduction.

4. Records: please ensure that, when possible, the following information is incorporated in each record included in a manuscript:-

(a) latin name of organism.

(b) statement of reference work used as the source of nomenclature employed in the text. The describer's name should be also given when a zoological species is first mentioned in the text.

(c) locality details including at least a four figure Irish grid reference (e.g. N3946), county or vice-county and some ecological data about the collection site, plus date of capture.

(d) Collector's name and determiner's name (where different from collector's name), and

(e) altitude data should be included where relevant.

5. Manuscripts should be submitted to the Editor, Dr J. P. O'Connor, at the following address:- National Museum of Ireland, Kildare Street, Dublin 2, Ireland or e-mailed to the Editor c/o ampersandwalsh@gmail.com.

RECORDS OF IRISH CHALCIDOIDEA (HYMENOPTERA) INCLUDING *TORYMUS HEDERAE* (WALKER, 1833) AND *TORYMUS NITIDULUS* (WALKER, 1833) NEW TO IRELAND

James P. O'Connor[1] and Csaba Thuróczy[2]

[1]*National Museum of Ireland, Kildare Street, Dublin 2, Ireland.*

[2]*9730 Koszeg, Malomarok 27, Hungary.*

Recently, CT identified a large collection of chalcidoids collected by J. P. O'Connor and M. A. O'Connor. Many of the records of the determined species are listed in Thuróczy and O'Connor (in press a). In this paper, *Torymus hederae* (Walker, 1833) and *T. nitidulus* (Walker, 1833) are reported for the first time from Ireland. Since the material also contained other interesting specimens of previously known Irish species, these records are included here and provide new distributional and flight-period data. A few miscellaneous records belonging to other collectors are also given. Voucher specimens will be deposited in the National Museum of Ireland.

The following abbreviations are used in the text:- CR – C. Reid; JPOC – J. P. O'Connor; MAOC – M. A. O'Connor; MRB – M. R. Boston; RN – R. Nash. Unless otherwise stated, the distributional data are from Anderson *et al.* (2008), O'Connor *et al*. (2000) and Thuróczy and O'Connor (2009, in press a, b). The symbol * indicates a new county record.

EULOPHIDAE: ENTEDONINAE

***Chrysocharis gemma* (Walker, 1839)**

***CAVAN**: Virginia Woods N5987, ♀ 20 March 1988, JPOC and MAOC; ***WATERFORD**: Portlaw Woods S4415, ♀ 1 April 1991, JPOC and MAOC; ***WEXFORD**: J. F. Kennedy Park S7319, ♀ 29 March 1989, JPOC and MAOC.

Previously recorded from Cos Dublin and Wicklow.

***Chrysocharis pallipes* (Nees, 1834)**

***CAVAN**: Virginia Woods N5987, ♂♀ 20 March 1988, JPOC and MAOC; ***CLARE**: Rathborney River M1906, ♂ 2 June 1992, swept from vegetation beside the river, ♀ 6 July 1989, JPOC; **DUBLIN**: Furry Glen, Phoenix Park O1035, ♂ 16 March 1992, JPOC; ***WATERFORD**: Ballin Lough S4403, ♀ 4 July 1989, JPOC and MAOC; Lismore Castle X0498, ♀ 17 July 1987, JPOC; ***WESTMEATH**: Ballynafid Lake N4060, ♀ 22 June 1989, JPOC; ***WEXFORD**: Tintern S7810, ♂ 28 March 1989, JPOC; **WICKLOW**: Avondale T1985, ♀ 27 May 1988, JPOC.

Previously from Cos Carlow, Dublin, Kildare and Wicklow.

***Chrysocharis pubicornis* (Zetterstedt, 1838)**

***KILDARE**: Donadea N8332, ♀ 11 October 1985, JPOC; Newbridge Fen N7616, ♀ 11 September 1985, JPOC.

Previously recorded from Cos Clare, Dublin, Kerry and Meath.

***Chrysocharis viridis* (Nees, 1834)**

***WEXFORD**: Ferrycarrig T0022, ♀ 3 June 1986, JPOC and MAOC.

Previously recorded from Cos Clare, Down and Kildare.

***Pediobius epigonus* (Walker, 1839)**

***WATERFORD**: Mahon Falls S3009, ♂ 3 July 1989, JPOC and MAOC; ***WEXFORD**: Curracloe T1127, ♂ 9 June 1982, old pasture/alder *Alnus* marsh, JPOC; Slieve Coiltia S7221, ♂ 14 June 1990, JPOC; ***WICKLOW**: Powerscourt O2012, ♀ 15 June 1988, JPOC.

Previously recorded from Cos Clare, Dublin and Kerry.

EULOPHIDAE: EULOPHINAE

***Aulogymnus arsames* (Walker, 1838)**

WICKLOW: Glendalough T1195, ♀ 24 April 1989, JPOC and MAOC.

Previously recorded from Cos Down and Wicklow.

***Aulogymnus gallarum* (Linnaeus, 1761)**

***CLARE**: Lough Bunny R3696, ♀ 28 May 1992, swept from vegetation beside the lake, JPOC; ***OFFALY**: Charleville Wood, Tullamore N3222, ♂ 28 April 1987, JPOC; ***WATERFORD**: Woodstock House, Inistioge S6336, ♀ 24 July 1987, JPOC; also ♀ 16 April 1990 JPOC and MAOC; ***WEXFORD**: Ballyanne S7330, ♂ 15 April 1990, JPOC; ***WICKLOW**: Glendalough T1195, ♂♀ 24 April 1989, JPOC and MAOC.

Previously recorded from Co. Dublin.

***Cirrospilus vittatus* Walker, 1838**

DUBLIN: North Bull Island O2337, 2♀♀ 16 October 1989, JPOC.

Previously only known from an unlocalised Irish specimen.

***Elachertus inunctus* Nees, 1834**

***WESTMEATH**: Pakenham Estate N4470, ♂ 23 July 1989, JPOC.

Previously known from Cos Down and Kerry.

***Hemiptarsenus ornatus* (Nees, 1834)**

***CLARE**: Cooleabeg M1602, ♂ 22 May 1985, damaged blanket bog in the Burren, JPOC and MAOC; near Formoyle M1606, ♂ 22 May 1985, green road in the Burren, JPOC and MAOC; ***MEATH**: Batterjohn Big N8953, ♀ 28 October 1991, sand quarry, JPOC and MAOC; ***OFFALY**: Charleville Wood, Tullamore N3222, ♂ 28 April 1987, JPOC; **WATERFORD**: Mahon Falls S3009, ♂ 3 July 1989, JPOC and MAOC; **WEXFORD**: Ballyteige S9504, ♀ 26 May 1987, sand-dunes, JPOC; Curracloe T1127, ♀ 10 June 1991, marshy area, JPOC.

Previously known from Cos Down, Dublin, Galway, Kerry, Laois, Sligo, Waterford, Wexford and Wicklow.

***Hemiptarsenus unguicellus* (Zetterstedt, 1838)**

***CLARE**: Corkscrew Hill M2020, Burren, ♀ 29 May 1992, hazel *Corylus* scrub, JPOC; **CORK**: Glengarriff V9057, ♂ 6 July 1985, oak *Quercus* wood, JPOC and MAOC; **KERRY**: Kenmare Estate, Killarney V9490, ♂ 8 September 1981, JPOC; **KILDARE**: Louisa Bridge N9936, ♂ 10 April 1989, swept in the marshy area, JPOC; **WATERFORD**: Ballin Lough S4403, ♂ 4 July 1989, JPOC and MAOC; Glasha River S3022, ♂ 8 July 1989, JPOC and

MAOC; **WEXFORD**: Curracloe T1127, ♀ 13 June 1991, sand-dunes, JPOC and MAOC.

Previously known from Cos Carlow, Cork, Down, Dublin, Galway, Kerry, Kildare, Meath, Tipperary, Waterford and Wexford.

***Pnigalio pectinicornis* (Linnaeus, 1758)**

***KILDARE**: Newbridge Fen N7616, ♀ 11 September 1985, JPOC; ***WEXFORD**: Fethard S7905, ♀ 10 June 1990, sand-dunes, JPOC.

Previously known from Cos Down, Laois and Wicklow.

***Pnigalio soemius* (Walker, 1839)**

***WATERFORD**: Lismore Castle X0498, ♀ 17 July 1987, JPOC; Passage East S6811, ♂ 13 June 1990, JPOC.

Previously known from Cos Galway and Kerry.

***Sympiesis sericeicornis* (Nees, 1834)**

***CLARE**: Lough Bunny R3696, ♀ 28 May 1992, swept from vegetation beside the lake, JPOC; ***KILDARE**: Newbridge Fen N7616, ♀ 11 September 1985, JPOC and MAOC.

Previously known from Cos Down, Dublin and Wicklow.

PTEROMALIDAE: MISCOGASTERINAE

***Halticoptera dimidiata* (Foerster, 1841)**

***ANTRIM**: Rea's Wood J1485, ♂ 30 June 1979, RN; ***WEXFORD**: Ballyteige S9504, ♀ 5 June 1986, sand dunes, JPOC and MAOC.

Previously known from an unlocalised Irish specimen.

***Halticoptera patellana* (Dalman, 1818)**

***DOWN**: Dundrum J4935, ♀ 8 July 1974, swept off birch *Betula*, CR; **KILKENNY**: Woodstock House S6336, ♀ 24 July 1987, JPOC; ***WATERFORD**: Nier Valley S2417, ♀ 13 July 1987, JPOC; Passage East S6811, 2♂♂ 13 July 1989, JPOC and MAOC also ♂ 3 July 1991; Portlaw S4415, ♂♂ 16 July 1987, JPOC and MAOC; ***WEXFORD**: Ballyhighland Wood S8840, ♂ 14 June 1982, JPOC and MAOC; Killoughrim Forest S9041, ♀ 16 June 1982, JPOC and MAOC; ***WICKLOW**: Powerscourt O2012, ♂♀♀ 15 June 1988, JPOC.

Previously known from Co. Dublin.

***Lamprotatus splendens* Westwood, 1833**

***ARMAGH**: Derryhubbert H6090, ♀ 7 October 1984, MRB.

Previously known from Cos Cavan, Clare, Donegal, Dublin, Kerry and Sligo.

***Miscogaster elegans* Walker, 1833**

***TYRONE**: Moy H8356, ♀ 23 July 1983, MRB.

Previously known from Cos Cavan and Kildare.

***Miscogaster maculata* Walker, 1833**

CAVAN: Virginia Woods N5987, ♂ 21 May 1989 and ♀ 27 October 1990, JPOC and MAOC; **CLARE**: near Fanore M1307, ♂♀♀ 24 May 1985 and ♂ 31 July 1988, green road in the Burren, JPOC and MAOC; near Formoyle M1606, ♀ 29 May 1992, green road, JPOC; Kilshanny R1292, ♂♂ 31 June 1992, hedgerows, JPOC; Lough Bunny R3696, ♀ 28 May 1992, swept from vegetation beside the lake, JPOC; ***DOWN**: Cultra J4180, ♂♂ 15 June 1963, MRB; **DUBLIN**: Malahide Castle O2253, ♂ 6 October 1985 and ♀ 13 October 1985, JPOC and MAOC; ***FERMANAGH**: Crom Eastate H3524, ♂ 1 June 1988, RN; **KILDARE**: Donadee N8332, ♀♀ 11 October 1985, JPOC; ***TYRONE**: Moy H8356, ♂ 19 June 1983, MRB; ***WATERFORD**: Ballin Lough S4403, ♀ 19 July 1987, JPOC; Lismore Castle X0498, ♀♀ 17 July 1987, JPOC; **WEXFORD**: Ballyteige S9504, ♀ 5 June 1986, sand-dunes, JPOC and MAOC; Curracloe T1127, ♀♀ 28 May 1987, JPOC; Ferrycarrig T0023 and T0022, ♂ 2 June 1986 and ♂ 30 March 1989, JPOC; Killoughrim Forest S8941, ♂ 4 June 1987, JPOC; Nethertown T1205, ♂ 6 June 1986 and ♀ 9 June 1986, willow *Salix* marsh, JPOC and MAOC; Oaklands S7125, ♂ 29 May 1987, JPOC; Stoneyford T1009, ♂ 13 June 1986, JPOC; **WICKLOW**: Avondale T1985, ♂♂♀ 27 May 1988 and ♂♂♀ 5 June 1989, JPOC; Glen of the Downs O2611, ♂♂ 22 August 1988, JPOC; Knocksink Wood O2117, ♂ 28 May 1989 and ♀♀ 19 October 1989, JPOC and MAOC; Powerscourt O2012, ♂ 15 June 1988, JPOC.

Previously known from Cos Cavan, Clare, Dublin, Kildare, Wexford and Wicklow.

***Miscogaster rufipes* Walker, 1833**

***KILDARE**: Donadee N8332, ♀ 11 October 1985, JPOC; ***WATERFORD**: Passage East

S6811, ♀ 13 June 1990, JPOC.

Previously known from Cos Cavan, Down and Dublin.

***Seladerma breve* Walker, 1834**

***ANTRIM**: Lough Neagh J6808, ♂ 2 May 1985, MRB.

Previously known from Co. Wexford.

***Seladerma diffine* (Walker, 1833)**

***CAVAN**: Virginia Woods N5987, ♀ 15 May 1989, JPOC; ***CLARE**: near Formoyle M1606, ♀ 29 May 1992, JPOC; ***CORK**: Rahan W6497, ♀ 6 July 1989, JPOC; **DUBLIN**: Slade of Saggart O0324, ♀ 1 November 1981, JPOC and MAOC; ***KERRY**: Killarney V9686, ♂ 11 September 1981, JPOC; ***KILKENNY**: Woodstock House, Inistioge S6336, ♀ 24 July 1987, JPOC; **TYRONE**: Moy H8356, ♂ 23 July 1983, MRB; ***WATERFORD**: Ballin Lough S4403, ♂♀♀ 4 July 1989, JPOC and MAOC; Dunhill Castle S5000, ♂♀ 11 July 1989, JPOC and MAOC; Glasha River S3022, ♀ 8 July 1989, JPOC and MAOC; Portlaw S4414, ♂♂♀♀ 16 July 1987, JPOC and MAOC; ***WESTMEATH**: Pakenham Estate N4470, ♂ 23 July 1989, JPOC; ***WEXFORD**: John F. Kennedy Park S7319, ♀ 26 March 1989, JPOC and MAOC , also ♂ 14 July 1987, JPOC; Oaklands S7125, ♂ 29 May 1987, JPOC also ♂ 10 June 1986; Tintern S7810, ♀ 28 March 1989, JPOC; **WICKLOW**: Glen of the Downs O2611, ♀ 22 August 1988, JPOC.

Previously known from Cos Down, Dublin and Wicklow.

***Stictomischus groschkei* Delucchi, 1953**

***KILDARE**: Newbridge Fen N7616, ♀ 11 September 1985, JPOC; **LAOIS**: The Derries N5805, ♀ 20 September 1992, JPOC.

Previously known from Cos Down and Sligo.

***Stictomischus scaposus* Thomson, 1876**

***DUBLIN**: Slade of Saggart O0324, ♀ 7 August 1981, JPOC; ***KILKENNY**: Woodstock House, Inistioge S6336, ♀ 24 July 1987, JPOC.

Previously known from Cos Antrim and Wicklow.

PTEROMALIDAE: PTEROMALINAE

***Callitula pyrrhogaster* (Walker, 1833)**

***WICKLOW**: Glendalough T1195, ♂ 11 September 1990, swept from vegetation beside the Upper Lake, JPOC.

Previously known from Cos Down, Dublin, Kildare, Mayo, Tipperary and Wexford.

***Cyrtogaster vulgaris* Walker, 1833**

DUBLIN: Slade of Saggart O0324, ♀ 1 November 1981, swept from vegetation beside a small stream, JPOC and MAOC; ***KERRY**: Golf Course beside the Lower Lake, Killarney V9291, ♀ 15 September 1981, JPOC; O'Sullivan's Cascade, Killarney V9188, ♀ 27 August 1987, swept from vegetation beside the waterfall, JPOC; ***TYRONE**: Moy H8356, ♀ 24 June 1982, MRB; **WATERFORD**: Mahon Falls S3009, ♂ 3 July 1989, JPOC and MAOC; **WEXFORD**: Ballyteige S9504, ♂♀ 26 May 1987, JPOC; Campile, ♀♀ 27 March 1989, JPOC; John F. Kennedy Park S7319, ♀♀ 26 March 1989, JPOC and MAOC; Killoughrim Forest S9041, ♀♀ 4 April 1988, JPOC; Nethertown T1205, ♀ 6 June 1986, willow *Salix* marsh, JPOC and MAOC; **WICKLOW**: Knocksink Wood O2117, ♀♀ 27 March 1987, JPOC.

Previously known from Cos Carlow, Cork, Dublin, Kildare, Kilkenny, Laois, Meath, Tipperary, Waterford, Wexford and Wicklow.

***Mesopolobus tibialis* (Westwood, 1833)**

***CAVAN**: Virginia Woods N5987, ♀ 15 May 1989, JPOC; **DUBLIN**: Phoenix Park O0935, ♂ 17 April 1982, JPOC and MAOC; ***KILDARE**: Carton Estate N9637, ♂ 29 April 1987, JPOC; ***WEXFORD**: Ballyhighland Wood S8840, ♀ 14 June 1982, JPOC and MAOC; Killoughrim Forest S8941, ♀ 27 May 1987, JPOC; ***WICKLOW**: Avondale T1985, ♂♂ 27 May 1988, JPOC; Powerscourt O2012, ♀ 15 June 1988, JPOC.

Previously known from Cos Cork, Dublin, Kerry and Tipperary.

***Plutothrix bicolorata* (Spinola, 1808)**

***CARLOW**: Cloughristick Wood S7069, ♀ 19 June 1982, JPOC and MAOC; ***TYRONE**: Moy H8356, ♀♀ 23 July 1983, MRB; ***WATERFORD**: Ballin Lough S4403, ♂ 18 June 1990, JPOC and MAOC; Glasha River S3022, ♂ 8 July 1989, JPOC and MAOC; Mount Congreve S5310, ♀ 4 July 1988 and ♂10 July 1989, JPOC; Passage East S6811, ♂ 3 July 1991, JPOC and MAOC; ***WESTMEATH**: Pakenham Estate N4470, ♂ 23 July 1989, JPOC; ***WEXFORD**: Killoughrim Forest S9041, ♀ 16 June 1982, JPOC and MAOC; River Fethard S7806, ♂ 17 June 1990, JPOC.

Previously known from Cos Cork, Dublin, Kildare, Leitrim, Meath and Wicklow.

***Sphegigaster pallicornis* (Spinola, 1808)**

***TYRONE**: Moy H8356, ♀♀ 15 April 1985, MRB.

Previously recorded from Ireland with no other details given.

TORYMIDAE: TORYMINAE

***Torymus arundinis* (Walker, 1833)**

***WATERFORD**: Ballin Lough S4403, ♀ 19 June 1991, JPOC; Belle Lake S6605, ♀ 11 June 1991, JPOC; Woodstown S6905, ♀♀ 2 July 1983, JPOC and MAOC; ***WESTMEATH**: Ballynafid Lake N4060, ♀♀ 22 June 1989, JPOC.

Previously known from Cos Wexford and Wicklow.

***Torymus auratus* (Müller, 1833)**

***MEATH**: Batterjohn Big N8953, ♀ 28 October 1991, sand quarry, JPOC and MAOC; WEXFORD: Killoughrim Forest S8941, ♀ 27 May 1987, JPOC.

Previously known from Co. Mayo.

***Torymus chloromerus* (Walker, 1833)**

***WATERFORD**: 2km north-west of Passage East (S6811), ♀ 12 June 1991, JPOC.

Previously known from Co. Mayo.

***Torymus erucarum* (Schrank, 1781)**

***KILKENNY**: Clonassy Wood S5622, ♀ 20 June 1990, JPOC and MAOC.

Previously known from Co. Mayo.

***Torymus flavipes* (Walker, 1833)**

***CAVAN**: Virginia Woods N5987, ♂♂♀ 15 May and ♀ 21 May 1989, JPOC and MAOC; ***CLARE**: Lough Bunny R3696, ♀ 28 May 1992, swept from vegetation beside the lake, JPOC; ***KERRY**: Torc Stream, Killarney V9684, ♀ 10 September 1981, JPOC; ***KILDARE**: Donadea Forest N8332, ♀ 14 June 1987, JPOC; ***KILKENNY**: Woodstock House S6336, ♂ 16 April 1990, JPOC and MAOC; ***OFFALY**: Charleville Wood N3222, ♂♂ 28 April 1987, JPOC; ***WATERFORD**: Knockaderry Reservoir S4905, ♂ 19 July 1987, JPOC; Passage East S6811, ♀ 13 June 1990, JPOC; **WEXFORD**: Ferrycarrig T0022, ♀ 21 April 1992, JPOC; Killoughrim Forest S9041, ♀ 27 May 1987, ♂ 27 March 1989, ♂♀♀ 19 April 1990, JPOC; **WICKLOW**: Glendalough T1195, ♀ 11 September 1990, JPOC; Mount Usher T2796, ♀ 27 May 1991, JPOC and MAOC.

Previously known from Cos Wexford and Wicklow.

***Torymus hederae* (Walker, 1833)** **New to Ireland**

***KILDARE**: Newbridge Fen N7616, ♀ 8 September 1991, JPOC and MAOC; ***WESTMEATH**: Belvidere House N4247, ♀ 28 August 1990, JPOC and MAOC.

T. hederae is also known from the Czech Republic, France, Great Britain, the Netherlands, Romania, Slovakia, Sweden and the Ukraine (Noyes, 2009; Popescu, 2006). Graham and Gijswijt (1998) states that the biology is unknown. However Noyes (2008) gives *Mikiola fagi* (Hartig) (Diptera: Cecidomyiidae) as a host. This species causes galls on beech (*Fagus*) but has not been recorded from Ireland (Chandler, O'Connor and Nash, 2008).

***Torymus nitidulus* (Walker, 1833)** **New to Ireland**

WESTMEATH: Belvidere House N4247, ♀ 31 May 1991, JPOC and MAOC; **WICKLOW**:

Powerscourt O2012, ♀ 15 June 1988, JPOC.

Elsewhere in Europe, *T. nitidulus* is known in Europe from the former Czechoslovakia, Germany, Great Britain, Hungary, the Netherlands, Romania, Russia, Sweden and the Ukraine. The species has also been reported from Mongolia, the Peoples' Republic of China, Turkey and the United States of America (Noyes, 2009). Graham and Gijswijt (1998) state that it has been reared from birch *Betula* catkins with *Semudobia* spp. (Diptera: Cecidomyiidae). Three species of this genus occur in Ireland (Chandler, O'Connor and Nash, 2008).

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A CATALOGUE OF THE ASELLOTA (CRUSTACEA: ISOPODA) OFF THE WEST COAST OF IRELAND AND BRITAIN, FROM 100-5000M

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Summary

This catalogue comprises a complete record of the deep-sea isopods collected off the west coast of Ireland and Britain to date. Benthic samples were taken over a two-year period by the zoobenthos group of the National University of Ireland, Galway, aboard the *RV Celtic Explorer*. Additional material collected as part of an environmental assessment by an Irish environmental consultancy (Aqua-Fact), was donated by the Galway-Mayo Institute of Technology, Galway. Further samples collected by the U.K. Department of Transport and housed at the National Museums of Scotland, Edinburgh, were also examined. Records from peer-reviewed literature, published catalogues and reports are included in the list. Information is provided on the type specimens, type locality and depth range of the species, where known.

Ten new records were reported for the area including one new species. An additional 15 new species were collected to be used in future research studies. It was noted that the species recorded in this area of the North East Atlantic bear an affinity to the fauna of the Northern Seas. A total of 40% of the species recorded in the study area are also found in the Northern Seas, supporting the hypothesis that the fauna of the Northern Seas consists of comparatively recent immigrants from the adjacent shelves. A comprehensive bibliography is provided and a history of deep-sea research in the area is presented.

Introduction

Historical background

The North Atlantic is one of the best researched areas in terms of the Isopoda, in particular, the Northern Seas. However, the taxonomy of isopods off the west coast of Ireland has traditionally only been studied in shallow water, with the majority of deep water taxonomy focusing on other groups such as the Polychaeta and the Mollusca. For example, a checklist of invertebrate groups from 100–2000m from Irish waters produced by Greenwood *et al.* (2001), displayed a paucity of crustacean and echinodermatan records in comparison to the groups above.

The North Atlantic was the birth place of deep sea biology during the late 19th century, and in 1868, the earliest expedition in Irish waters was carried out aboard the *HMS Lightning* by Carpenter and Thompson (1870). The survey consisted of dredges, in depths of up to 970m (Carpenter, 1868). Thompson and Carpenter, along with Jefferys, also carried out an expedition aboard the *HMS Porcupine* in 1869, which sampled at approximately 45 stations off the west coast of Ireland. The results of this survey showed that animal life existed down to depths of 650 fathoms (1188m), that all marine invertebrate groups are present at this depth, and that deep sea temperatures vary considerably and indicate oceanic circulation (Thompson, 1873).

Building on the success of the *HMS Lightning* and *HMS Porcupine*, several other expeditions were carried out in the late 19th and early 20th centuries (see Table 1) that contributed significantly to our knowledge of deep sea fauna. The *HMS Challenger* expedition from 1873–1876 is perhaps the best known expedition, and is considered to have laid the foundations for almost every branch of oceanography as we know it today. Wyville Thompson was the scientific director of the survey, which lasted for three years and covered much of the world's oceans. Unfortunately, little of the survey took place in Irish waters. Tattersall (1905) described several new asellote species, collected aboard the gunboat the *Helga*, from 1901–1904; this comprised the majority of our knowledge of deep-sea isopods in Irish waters until recent years. With the outbreak of World War I in 1914, research abruptly stopped in Irish waters, and in the North East Atlantic as a whole, and it was not until the 1960s that the deep

sea again became a focal point for research.

In the 1960s, significant work carried out by Sanders, Hessler and colleagues on the continental margin of the northeastern United States showed that the macrofauna is abundant and highly diverse in the deep-sea (Hessler and Sanders, 1967; Sanders, 1968; Sanders and Hessler, 1969). Up until this point it had been thought that deep-sea animals displayed low diversity. In 1972, the Scottish Marine Biological Association (SMBA), now known as the Scottish Association for Marine Science (SAMS), began a time series study of the megafauna in the Rockall Trough that continues to the present day. They collected data from two permanent stations in the area, one at 2200m and one at 2900m. A large number of publications have been produced from this work. In terms of the Isopoda, the most significant work was published by Lincoln and Boxshall (1983) and Lincoln (1985), in which they described the Dendrotionidae and Haploniscidae collected in the region; and by Harrison in 1987, in which he described specimens of the family Thambematidae. In 1988, a preliminary analysis of asellote isopods in the area was published by Harrison, the majority of these specimens (85%) was identified to genus level only. A large amount of data on isopods from this region exists but has not been published; a database containing this information is currently under construction by SAMS. In the mid 1970s, Woods Hole Oceanographic Institute (WHOI) carried out a series of transects in Irish waters, to the northwest and southwest of the country and elsewhere in the Atlantic Ocean using an epibenthic sled. Although some of this material has been illustrated (Kavanagh *et al.*, 2006), much of it remains undescribed. It was also in the late 1970s that the Institute for Oceanographic Sciences-Deacon Laboratory (IOSDL), now known as Southampton Oceanographic Centre (SOC), commenced its Porcupine Seabight programme. This led to the formation of the Porcupine Abyssal Plain (PAP) observatory in 1989, for the purpose of facilitating repeated studies concentrating on the effect of processes (biological, chemical and physical) in the upper ocean on the seabed. SOC have been very successful in terms of numbers of publications resulting from work carried out on the PAP, but again, little information on isopod diversity has been recorded. In 1987, BIOFAR was established for the sole purpose of surveying benthic macrofauna in waters around the Faeroe Islands. BIOFAR I ran from 1988–

1990 and collected about 800 samples from depths of 100–1100m. BIOFAR 2 ran from 1993–1995 and concentrated on shallow water areas, from the littoral to the 100m line (see Table 1 for details of all the research initiatives).

In the late 1990s, thanks to an upsurge in the global economy, several large scale projects were undertaken in Irish and British waters. The Marine Science and Technology programme (MAST), funded by the European Union, funded three projects (MAST I–III), from 1990–1998 with the aim of developing new technologies for the exploration, protection and exploitation of marine resources. These were based in the North Atlantic Ocean. Several projects were established in association with oil producing companies. For example, the Atlantic Frontier Environmental Network (AFEN) was established in 1995, and consisted of a consortium of oil companies with interest in the U.K. Atlantic Margin Oil Province. The objective of the network was to 'understand the environment better, and to establish an environmental baseline for the licensed area'. The four main areas of research were the seabed, cetaceans, seabirds and coastal protection. In 1999, the U.K. Department of Transport and Energy (DTI), a member of AFEN, established the Strategic Environmental Assessments (SEA) which are still running. The aim of these projects, with seven phases (SEA1–SEA7) is to assess the implications of further licensing of the U.K. Continental Shelf (UKCS) for oil and gas exploration and production, with SEA 6 due to commence in 2006. The projects are being carried out by SOC.

In Ireland, the Petroleum Infrastructure Programme (PIP) was established in 1997, with its primary aim to promote hydrocarbon exploration in Ireland. Two subprogrammes exist under the PIP. From 1997–2002, three groups functioned within the subprogramme PIP- the Rockall Studies Group (RSG), the Porcupine Studies Group (PSG) and the Offshore Studies Group (OSG). In total, 58 projects were funded during this time. Biological projects concentrated mainly on cetacean and seabird research based at University College Cork (UCC). From 2002 onwards, a second subprogramme was established *viz.* the Petroleum Exploration and Production Programme Support (PEPPS). Within this programme, the Expanded Offshore Support Group (EOSG) and the Irish Shelf Petroleum Study Group (ISPSG) operate and are currently supporting 41 and 38 projects respectively.

To summarise, despite the large number of studies which have been carried out in the deep-sea area, few of these have been taxonomically orientated. Projects focus instead on creating an understanding of ecological and hydrographic processes, or, where faunal diversity is studied, vertebrate and larger invertebrate groups, including Crustacea such as the Decapoda, are favoured. In many cases, isopod samples remain unsorted or identified to family/genus level only. In 2003, the Irish government launched the first Irish deep-sea research vessel, the *RV Celtic Explorer*. In conjunction with this, the Higher Education Authority (HEA) of Ireland funded a multidisciplinary project under PRTLI Cycle III at the National University Ireland Galway (NUIG), with deep-sea research in the area of geophysics, microbiology, oceanography and benthic zoology. Within the zoology sector, work has focused on taxonomic work of the main benthic invertebrate groups recorded in the deep-sea (Polychaeta, Mollusca and peracarid Crustacea). One of the aims of the group was to build up knowledge of the species found in the area off the west coast of Ireland, and in particular, the Porcupine Bank and surrounding areas.

The Isopoda consist of nine suborders:- Anthridea, Anthuridae, Asellota, Epicaridea, Flabellifera, Gnathiidae, Oniscidea, Phreatoicidea and Valvifera. This catalogue focuses on the Asellota. Within the Isopoda, the Asellota are by far the largest suborder and dominate deep-sea isopod samples, comprising approximately 90% of samples (Wilson, 1989; Poore and Wilson, 1993).

Isopod biology

Definition: The Isopoda is a monophyletic order of crustaceans within the superorder Peracarida containing 9,000–11,000 named marine, freshwater and terrestrial species (Bruce, 2001; Brusca and Brusca, 2002).

Peracarida are defined within the Malacostraca by the possession of a ventral thoracic marsupium (pouch) in which the eggs are brooded. Isopoda undergo direct development within the marsupium (as do other Peracarida), and emerge as juveniles known as manca. Adults possess seven pairs of thoracic appendages; manca lack the last pair of legs which then develop prior to adulthood. Within the Peracarida, 13 synapomorphies unite the Isopoda within a monophyletic clade including, for example, the reduced carapace which forms a cephalic shield,

biphasic moulting and sessile eyes. Although some of these synapomorphies are present within a second peracarid group, the Amphipoda, this is a result of convergence (Brusca and Wilson, 1991). Much debate exists as to which suborders of the Isopoda are primitive, and which are derived. Strömberg (1972), Kussakin (1973, 1979) and Bruce (1981) advocated that the suborder Flabellifera contains the primitive isopods, and that the Asellota are derived. From the Flabellifera, the Cirolanidae are chosen as the model for the archetypical ancestral isopod by most workers. Other workers including Monod (1922), Hansen (1925) and Schmaulfuss (1989) supported the converse theory: that the Asellota are primitive, and the Flabellifera are derived. Phylogenetic analyses on the isopod suborders by Schram (1974), Wägele (1989) and Brusca and Wilson (1991) concluded that the Phreatoicidea are the most primitive group of Isopoda, a hypothesis supported by the fact that the oldest isopods fossils are Phreatoicidea from the Upper Carboniferous era, 300 million years ago. Brusca and Wilson (1991) found the Asellota and Microcerberidea to be sister-groups, and the next most primitive following the Phreatoicidea. The suborders of Isopoda can be generally divided into groups based on the morphology of the uropods. 'Short-tailed' isopods have styliform uropods as observed in the Phreatoicidea, Asellota, Microcerberiidea, Calabozoidea and Oniscidea. 'Long-tailed' isopods have biramous lamellar uropods e.g. Flabellifera, Valvifera, Anthuridea, Gnathiidea and Epicaridea. Brusca and Wilson (1991) consider the 'short-tailed' morphology to be plesiomorphic for the Isopoda.

Wetzer (2002) carried out molecular analysis on all the suborders of Isopoda to test the two main hypotheses put forward by Brusca and Wilson (1991). Firstly, that the Phreatoicidea are the earliest living isopods, and secondly, that the long-tailed isopod morphology is the derived condition within the isopods. The phylogeny estimated from the combined 12s rDNA: 16s rDNA 6P (six-parameter parsimony) analysis corroborates Brusca and Wilson's (1991) analysis. Other aspects of the analysis are contradictory to this result: the 12s rDNA analysis shows that asellotans are ancestral to the Phreatoicideans, a hypothesis favoured by Schmaulfuss (1989), while the 16s rDNA data placed the Oniscidea at the base, with the Phreatoicidea as more derived. Wetzer (2002) concluded that the variation in placement of ancestral and derived isopods suggest that higher order characters from slower evolving genes

will be needed to more strongly support the deeper nodes of the phylogeny, and that hypotheses based on the results should be judged cautiously.

Regardless of whether they are primitive or derived, the Asellota exhibit a large degree of diversity, both at the family and the species level. Body shape, for example, can range from being elongated and slender (Ischnomesidae) to being broad and depressed (Haploniscidae). Some families such as the Dendrotionidae have very spinose bodies and the Ilyarachnidae have enlarged heads to accommodate crushing jaws. Taxa within the Asellota exhibit marked depth zonation, and the families display increased specialization with increasing depth, such as the lack of eyes, uniramous uropoda and a reduction in the number of thoracic appendages. In families which have representatives in both shallow and deep water, the more primitive families occur in shallow water, with more specialized families dominating in the deep sea (Hessler *et al.*, 1979). An exception to this pattern occurs at high latitudes, where specialized families occur in shallow water.

The ultimate origin of the isopod fauna has been argued by Kussakin (1973) to be in the Antarctic Ocean, and one hypothesis suggests that asellote evolution occurred in shallow water and that the presence of Asellota in the deep sea then occurred as a result of invasion from shallow water at high latitudes such as the Antarctic Ocean. The alternative hypothesis states that the initial invasion of the deep sea by shallow water species was followed by a large amount of radiation *in situ*, and the presence of asellote families at shallow high latitudes is a result of subsequent emergence. Three lines of evidence were put forward by Hessler and Wilson (1983) to support the latter hypothesis. Firstly, both generic and specific diversity have their centres in the deep-sea. Hessler and Thistle (1975) had previously advanced this argument using the distribution of the asellote family Ilyarachnidae as an example. They pointed out that the most primitive species of the family, *Ilyarachna abyssorum* Richardson, is found only in the abyss. The genus *Ilyarachna* was noted to have its greatest species diversity at 2400m, and to be cosmopolitan in the deep-sea, even though it is also present in shallow waters of both the North and South Poles. Secondly, the most primitive genera or species of deep-sea families live in deep-water, not shallow water. In the example of Hessler and Thistle, the eurycopid genus

Betamorpha, which is hypothesized to be the ancestor of the family Ilyarchnidae, is found only and abundantly in the deep sea. All these facts support the hypothesis of deep-sea evolution.

If a taxon bears a morphological imprint that it could only have gained in one of its ecological areas, this provides a criterion for choosing one area over the other as the source of evolution (Hessler and Thistle, 1975). One such imprint is the absence of eyes in deep-sea asellote families. Hessler and Thistle (1975), as well as Hessler and Wilson (1983), used this morphological character to support their hypothesis. The deep-sea families are all blind, even those representatives that are found in shallow water. Conversely, those families which are common in shallow water and possess eyes, lose these eyes as they move into deeper water. Because eyes are plesiomorphic in isopods, lack of them implies regression in an environment where they offer no selective advantage, such as the deep-sea (Hessler and Wilson, 1983). This is an example of the irreversibility of evolution, where a character that has been lost, cannot be retrieved. To further reinforce this theory, one can examine the lifestyle of those isopods that move into deep-water. The majority of deep-sea families that show high-latitude emergence are adapted for swimming. It is highly unlikely that swimming forms of Isopoda in shallow water should lose eyes, unless they had previously evolved without them in such an environment as the deep-sea.

If one accepts the theory of deep-sea evolution for asellote isopods, the next question which must be considered is 'Why have the Isopoda undergone such a remarkable radiation in the deep sea?' The most obvious explanation is that they evolved earlier than other taxa in the deep-sea, which allowed time for the diverse morphological adaptations that we observe today. Hessler and Wilson (1983) suggest that their success is probably due to a detritivorous life style, which is favoured in the deep-sea because of factors such as lower prey densities. Nevertheless, most genera of Isopoda are ubiquitous, which indicates that they must have been in the deep-sea long enough to become evenly distributed. In general, peracarids are rarely preserved as fossils. As mentioned above, the oldest isopod fossils are the Phreatoicidea from the Upper Carboniferous era. These fossils are well-developed, indicating that isopods first appeared prior to this era. The realization of the deep-sea as the centre of asellote evolution highlights the

importance of deep-sea sampling in resolving taxonomic difficulties within the suborder.

Study area

The study area ranged from 48°N to 62°N and as far west as 20°W, including depths from 100m-5000m. The area included is shown in Figure 1. It was decided to include areas north and northwest of Britain, including the Faeroe Islands, as significant work has been carried out in recent years (see Table 1), and the species collected are likely to be present in samples from Irish waters.

Materials and methods

The material examined consisted of samples collected by NUIG aboard the Irish Marine Institute's research vessel, the *RV Celtic Explorer*, from 2003–2004. Samples collected as part of the SEA 1 and SEA 4 projects by DTI U.K. and housed at the National Museums of Scotland were also examined. Samples from other SEA projects carried out thus far are not relevant to the study as they are taken from the coastal areas of the U.K. Finally, material collected by the Galway-Mayo Institute of Technology (GMIT), as part of an environmental assessment by an Irish environmental consultancy, Aqua-Fact, were also examined. Records from peer-reviewed literature, and published catalogues and reports were also used. Unpublished records where the material was not examined directly were excluded.

Specimens collected by G. O. Sars were seldom labeled as 'type', with the result that it is unclear what specimens he described in his publications. G. O. Sars' material is held at ZMO, and in many instances needs to be examined directly in order to confirm the existence of type specimens. This situation is also true of several other taxonomists from the 19th and early 20th century, and the type material is described as 'unknown' below. In addition, G. O. Sars did not give precise locations for the collection of his material, in many cases stating just a general geographical area, and this is reflected in this catalogue.

All station numbers are given as originally listed. In some cases this may mean using the previous name of an institution, e.g. SMBA station x, IOS station x. The coordinates for the

SMBA permanent stations mentioned in the introduction are: 55°N, 12°W, 2900m and 57°N, 12°W, 2200m. Throughout the text, the stations are referred to as SMBA permanent station, 2900m or SMBA permanent station, 2200m.

Table 1 lists all surveys carried out in the study area. Some additional surveys carried out near the study area are also included as type material collected from these surveys has since been recorded in the study area. These include: the Danish *Ingolf* and *Galathea* expeditions, the Swedish *Ymer* expedition, the Swedish-French NORBI expedition, the U.S. led FRAM I Drift-Ice expedition, the German *RV Håkon Mosby* expeditions and the French Campagne Noratlante, Waldo, Biogas and Biaçores surveys.

The following abbreviations are used:-

AFEN: Atlantic Frontier Environmental Network.

AMNH: American Museum of Natural History.

DTI: Department of Transport and Industry (UK).

IOS: Institute of Oceanographic Sciences, Wormley.

IOSDL: Institute of Oceanographic Sciences, Deacon Laboratory.

MHN: Museum d'Histoire Naturelle, Paris.

NHM: Natural History Museum, London.

NUIG: National University Ireland Galway.

OMEX: Ocean Margin Exchange.

SAMS: Scottish Association of Marine Science.

SEA: Strategic Environmental Assessments (run by DTI above).

SMBA: Scottish Marine Biological Association.

SOC: Southampton Oceanographic Centre.

ZMO: Zoological Museum of Oslo.

ZMUB: Zoological Museum of the University of Bergen.

ZMUC: Zoological Museum of the University of Copenhagen.

Results

The following is a catalogue of all asellote Isopoda recorded from 100-5000m in the study area outlined above. New Irish records are indicated by an asterisk (*).

ORDER ISOPODA

SUBORDER ASELLOTA LATREILLE, 1803

FAMILY DENDROTIONIDAE VANHOEFFEN, 1914

Genus *Dendrotion* G. O. Sars, 1872

Species name: *Dendrotion elegans* Lincoln and Boxshall, 1983

Dendrotion elegans Lincoln and Boxshall, 1983: 309–310, fig. 6.

Type locality: Rockall Trough. SMBA station 197, (1981) 57.21°N, 10.29°W, 2200m.

Type material: ♂ holotype, NHM reg. no. 1983: 101. 6♂♂ 53♀♀ paratypes, same locality as the holotype.

Distribution: Rockall Trough.

Records: type locality; additional ♀ collected by SMBA station 105 (1981) at 58.27°N, 12.35°W, 1600m.

***Species name**: *Dendrotion paradoxum* Hansen, 1916 **New to Ireland**

Dendrotion paradoxum Hansen, 1916: 51–52, pl. IV, figs 3a–3e.

Type locality: south west of Iceland. *Ingolf* station 78, 60°37'N, 27°52'W, 799 fathoms (1504m).

Type material: lectotype, ZMUC: CRU 7710.

Records: collected by NUIG (2004) at 52°49.97'N, 12°39.83'W, 441m.

Species name: *Dendrotion setosum* Lincoln and Boxshall, 1983

Dendrotion setosum Lincoln and Boxshall, 1983: 305–309, figs 4A–E, 5A–J.

Dendrotion spinosum Hansen, 1916: 50 pl. IV, figs 2a–2c.

Type locality: Rockall Trough. SMBA station 99 (1976) 66°00'N, 10°35'W, 1160m.

Type material: ♂ holotype, NHM reg. no. 1983: 99.

Distribution: recorded throughout the North East Atlantic.

Records: 5 additional ♂♂ collected by SMBA at Rockall Trough, station 12 (1976), 56°49'N, 10°15'W, 2076m; collected by NUIG in 2004 at 52°49.97'N, 12°39.83'W, 441m; 53°14.46'N, 14°46.05'W, 979m; collected by SEA 1 at 61°00.98'N, 2°31.80'W, 543m and 60°59.44'N, 2°29.52'W, 495m.

Species name: *Dendrotion spinosum* G. O. Sars, 1872

Dendrotion spinosum G. O. Sars, 1872: 273; Hansen, 1916: 50–51, pl. IV, figs 2a–2c.

Type locality: Hardanger Fjord, 150 fathoms (282m).

Type material: ZMO (data unavailable).

Distribution: North East Atlantic, North Sea.

Records: collected by AFEN 1996 at 60°57.71'N, 2°24.99'W, 408m.

Genus *Dendromunna* Menzies, 1962

Species name: *Dendromunna compsa* Lincoln and Boxshall, 1983

Dendromunna compsa Lincoln and Boxshall, 1983: 299–304, figs 1A–H, 2A–G, 3A–J.

Type locality: collected by SMBA at their permanent station in the Rockall Trough. 54°39'N, 12°17'W, 2900m.

Type material: holotype ♂ by original designation, NHM reg. no 1983: 97.

Distribution: recorded at numerous stations throughout the Rockall Trough by SMBA.

Records: all records are from the Rockall Trough.

FAMILY DESMOSOMATIDAE G. O. SARS, 1897

Genus *Eugerda* Meinert, 1890

Species name: *Eugerda tenuimana* (G. O. Sars, 1868)

Desmosoma tenuimanum G. O. Sars, 1868: 114–115.

Type locality: Langesund, south Norway, 0–50m.

Type material: ZMO (data unavailable).

Distribution: North East Atlantic.

Records: *Desmosoma* ?*tenuimanum* collected by AFEN 1996 at 61°36.16'N, 2°26.56'W, 1484m; collected by the *Helga* in 1906 60 miles (97km) west of Achill Island, County Mayo, 199 fathoms (364m).

Genus *Eugerdella* Kussakin, 1965

Species name: *Eugerdella hessleri* Just, 1980

Eugerdella hessleri Just, 1980: 203–206, fig. 5; Svavarsson, 1988A, 21–25, figs 16–17.

Type locality: collected on FRAM I Drift-Ice Expedition (1979). 84°10.38'N, 7°48.52'W, 3620m. Bottom type of soft brown foraminiferous clay, trapped in bottom hydrophone.

Type material: preparatory ♀ holotype, ZMUC CRU-6702.

Distribution: North East Atlantic.

Records: *Eugerda* ?*hessleri* collected by SEA 1 61°54.95'N, 2°48.06'W, 1624m.

Genus *Desmosoma* G. O. Sars, 1864

Species name: *Desmosoma lineare* G. O. Sars, 1864

Desmosoma lineare G. O. Sars, 1864: 11; 1866: 114–115; 1867: 125–126, pl. LIII, pl. LIV, fig 1; 1897: 126; 1899, figs 53–54.

Type locality: Straits of Drøbak.

Type material: ZMO (data unavailable).

Distribution: North East Atlantic.

Records: collected by the *Helga* 77 miles (124km) west of Achill Head, County Mayo, 382 fathoms (699m); collected by NUIG at 53°14.55'N, 14°55.45'W, 1564m, using an epibenthic sled.

Genus *Oecidiobranchus* Hessler, 1970

Species name: *Oecidiobranchus nanseni* Just, 1980

Oecidiobranchus nanseni Just, 1980: 206–209, fig. 6.

?*Desmosoma plebejum* Menzies and Mohr, 1962: 197, fig. 2A–B.

Type locality: collected by FRAM I Drift-Ice Expedition. Station 18: 83°40.08'N, 6°49.21'W, 2300m. Bottom type clay, sand, gravel, pebbles, empty shells.

Type material: brooding ♀ holotype, ZMUC CRU–7485. Brooding ♀ and preparatory ♀ paratypes (same locality as holotype), ZMUC CRU–7486.

Distribution: North East Atlantic.

Records: *Oecidiobranchus* ?*nanseni* collected by SEA 1 at 59°34.66'N, 8°55.38'W, 1389m and 61°55.03'N, 2°48.30'W, 1622m.

FAMILY HAPLONISCIDAE HANSEN, 1916

Genus *Antennuloniscus* Menzies, 1962

Species name: *Antennuloniscus simplex* Lincoln, 1985

Antennuloniscus simplex Lincoln, 1985: 687–690, figs 18a–i, 19a–I; Kussakin, 1988: 412.

Type locality: Rockall Trough, South Feni Ridge. SMBA Station 112, 55°12'N, 15°50'W, 1900m.

Type material: ♂ holotype, NHM reg. no. 1984: 192. Paratypes: NHM reg. no. 1984: 193.

Distribution: known only from type locality.

Records: type locality.

Species name: *Antennuloniscus diversus* Lincoln, 1985

Antennuloniscus diversus Lincoln, 1985: 690–693, figs 20a–i, 21a–i; Kussakin, 1988: 414.

Type locality: IOS Station 101121, 50°25'–50°26.4'N, 13°19.1'–13°17.6'W, 2648–2660m.

Type material: ♂ holotype, NHM reg. no. 1984: 190. Paratypes 1984: 191.

Distribution: North East Atlantic.

Records: recorded by Lincoln from SMBA stations in Rockall Trough, and IOS stations in the

Porcupine Abyssal Plain; collected by NUIG at 53°59.90'N, 13°59.95'W, 1800m, and 54°08.63'N, 13°59.95'W, 2200m.

Genus *Chauliodoniscus* Lincoln, 1985

Species name: *Chauliodoniscus armadilloides* (Hansen 1916)

Haploniscus armadilloides Hansen, 1916: 31, pl. II, figs 4a–4d.

Chauliodoniscus armadilloides Lincoln, 1985: 682–687, figs 15c–i, 16a–h, 17a–h. Kussakin, 1988: 402.

Type locality: south east of Iceland. *Ingolf* station 54, 63°08'N, 15°40'W, 301m.

Type material: ♀ holotype, ZMUC CRU-5601.

Distribution: South East Iceland, Rockall Trough, Porcupine Bank.

Records: Recorded by Lincoln from collections by SMBA at numerous Rockall Trough stations within the sector 54°34'N–57°21'N, 10°29'W–12°29'W, 2200–2925m and from two IOS stations in the Porcupine Sea Bight, station 101122, 50°25.2'–50°25.7'N, 13°20.3'–13°20.4'W; station 506041, 50°6.1'–50°6.4'N, 13°53'–13°49.9'W, 2640–3550m; collected by SMBA at their permanent station in the Rockall Trough: 54°40'N, 12°17.5'W, 2900m.

Genus *Haploniscus* Richardson, 1908

Species name: *Haploniscus aduncus* Lincoln, 1985

Haploniscus aduncus Lincoln, 1985: 682, figs 15a–b; Kussakin, 1988: 380.

Type locality: IOS station 7709, 60°7.1'–60°6.1'N, 19°30.3'–19°24.8'W, 2636–2646m.

Type material: ♀ holotype, NHM reg. no. 1984: 188.

Distribution: Rockall Trough.

Records: type locality.

Species name: *Haploniscus ampliatus* Lincoln, 1985

Haploniscus ampliatus Lincoln, 1985: 663–666, figs 3a–h, 4a–i; Kussakin, 1988: 371.

Type locality: Porcupine Bank. SMBA station 37, 54°37'N, 12°19'W, 2900m.

Type material: ♂ holotype, NHM reg. no. 1984: 178.

Distribution: Porcupine Bank, Iceland Basin.

Records: type locality; several SMBA stations on the Porcupine Bank from 54°34'–54°42'N and 12°11.5'–12°22'W, 2636-2925m.

Species name: *Haploniscus angustus* Lincoln, 1985

Haploniscus angustus Lincoln, 1985: 676–679, figs 11a–j, 12a–j; Kussakin, 1988: 390.

Type locality: Rockall Trough. SMBA station 143, 54°41'N, 12°14'W, 2892m, using an epibenthic sled.

Type material: ♂ holotype by original designation, NHM reg. no. 1984: 185. Paratypes, NHM reg. no. 1984: 186.

Distribution: Rockall Trough, Porcupine Bank.

Records: type locality, collected by SEA 1 at 61°34.42'N, 2°00.42'W, 1231m; several SMBA stations in the Rockall Trough, including permanent station at 2900m; IOS stations on the Porcupine Bank, 1484–2910m; collected by NUIG on the Porcupine Bank from 53°00.07'N, 15°59.81'W, 3283m.

Species name: *Haploniscus bicuspis* (G. O. Sars, 1877)

Nannoniscus bicuspis G. O.Sars, 1877: Sars, 1855: 122, pl. 10, figs 31–35.

Haploniscus bicuspis Hansen, 1916: 29, pl. 2, fig. 2; Menzies, 1962: 96, figs 6A–D; Gurjanova, 1964: 258; Svavarsson, 1988B: 85–86; Kussakin, 1988: 365.

Type locality: east of Iceland. 65°53'N, 7°18'W, 1163 fathoms (2130m). Bottom temperature -1.1°C.

Type material: ♀ holotype, ZMO F1716.

Distribution: Rockall Trough, Faeroe Islands.

Records: collected by SMBA at 3 stations in the Rockall Trough, stations 12, 87, 197 from 56–61°N and 3–11°W, 1050–2200m. Specimens deposited in NHM reg. no. 1984: 177.

Haploniscus ?bicuspis collected by SEA 1 at 59–63°N, 1–6W, 0–0° 35.18'E, 785–1582m.

Species name: *Haploniscus borealis* Lincoln, 1985

Synonym: *Haploniscus* Lincoln, 1985: 673–676, figs 9a–i, 10a–j; Kussakin, 1988: 378.

Type locality: Porcupine Bank. SMBA station 15, 56°44'N, 09°28'W, 1632m.

Type material: holotype, NHM reg. no: 1984: 183. Paratypes, NHM reg. no: 1984: 184.

Distribution: Rockall Trough, Porcupine Bank.

Records: collected by IOS from several stations on the Porcupine bank; by SMBA throughout the Rockall Trough; by NUIG at 53°14.55'N, 15°5.45'W; 53°15.22'N, 14°50.43'W; 52°49.97'N, 12°39.83'W, 441–1564m.

Species name: *Haploniscus foresti* Chardy, 1974a

Haploniscus foresti Chardy, 1974a: 1139–1141, fig. 1–2; Lincoln, 1985: 669–673. figs. 7a–i, 8a–h; Kussakin, 1988: 399.

Type locality: Campagne Noratlante, station 2. 53°54.9'N, 17°51.8'W, 2456m.

Type material: ♀ holotype, deposited at the MNHN.

Distribution: Rockall Trough, Porcupine Bank.

Records: collected by NUIG at 53°00'N, 15°59'W, 3283m; collected by SMBA in the Rockall Trough, including their permanent station at 2900 m and IOS on the Porcupine Bank at depths from 1632–3697m.

Species name: *Haploniscus hamatus* Lincoln, 1985

Haploniscus hamatus Lincoln, 1985: 667–669, figs. 5a–j, 6a–k; Kussakin, 1988: 381.

Type locality: Rockall Trough. SMBA station 137, 54°34'N, 12°19'W, approx 2900m.

Type material: ♂ holotype, NHM reg. no. 1984: 180.

Distribution: Rockall Trough, Iceland Basin.

Records: recorded by SMBA from several stations in the Rockall Trough within the sector 54°34'–54°42'N, 12°11.5'–12°22'W, 2878–2925m.

Species name: *Haploniscus ingolfi* Wolff, 1962

Haploniscus ingolfi Wolff, 1962: 56, pl. 2, figs A–B, text figs 23–24; Chardy, 1974a: 1165; Lincoln, 1985: 679–682, fig. 13a–l, 14a–h; Svavarsson, 1988B: 86, fig. 1; Kussakin, 1988: 376.

Type locality: south of Jan Mayen, Norway. *Ingolf* station 113, 69°31'N, 7°06'W, 2465m.

Type material: ♀ holotype, ZMUC CRU–6831; non-type from the Rockall Trough deposited by Lincoln in the NHM, reg. no. 1984: 187.

Distribution: North Polar Sea, North Atlantic Ocean.

Records: collected by SMBA from several stations in the Rockall Trough at 54°34'N–54°41'N and 12°3'W–12°19'W, 2892–2916m; by NUIG west of the Porcupine Bank 53°00'N, 15°59'W, 3283m.

FAMILY MUNNOPSIDAE LILJEBORG, 1864

Genus *Bathybadistes* Hessler and Thistle, 1975

Species name: *Bathybadistes spinosissima* (Hansen, 1916)

Ilyarachna spinosissima Hansen, 1916: 127–128, pl. XI, figs 10a–10e, pl. XII, figs 1a–1c.

Bathybadistes spinosissima Hessler and Thistle, 1975: 163.

Type locality: Davis Strait. *Ingolf* station 36, 61°50'N, 56°21'W, 1435 fathoms (2702m).

Type material: ♂♀ labeled 'type', ZMUC CRU-8212, CRU 9248.

Distribution: Rockall Trough, Davis Strait.

Records: collected by SMBA at their permanent station in the Rockall Trough, 54°40'N, 12°17.5'W, 2900m between November 1973 and May 1983.

Genus *Disconectes* Wilson and Hessler, 1981 **New to Ireland**

***Species name**: *Disconectes furcatus* (G O Sars, 1870)

Eurycope furcata G. O. Sars, 1870: 165; G. O. Sars, 1898: 148, pl. 67, fig. 2; Hansen, 1916: 151, pl. XIII, figs 9a–9b; Menzies, 1962: 140, fig. 33C–F.

Disconectes furcatus Wilson and Hessler, 1981: 406.

Type locality: Lofoten Islands at Skraaven, Norway. 100–200 fathoms (188–377m).

Type material: ZMO (data unavailable).

Distribution: North East Atlantic.

Records: collected by NUIG in 2004 at 52°49'N, 12°39'W; 53°14'N, 14°46'W; 53°12'N, 14°39'W, 441–979m.

Eurycope ?*furcata* collected by AFEN 1996 at 60°46'N, 2°55'W, 390m.

Species name: *Disconectes latirostris* (G. O. Sars, 1882)

Eurycope latirostris G. O. Sars, 1882: 67, pl. 2, fig. 6; 1898: 148, pl. LXVII, fig. 1.

Disconectes latirostris Wilson and Hessler, 1981: 406.

Type locality: west of Norway. 188–536m.

Type material: ZMO (data unavailable).

Records: collected by the *Helga* 60 miles (97km) west of Achill Head, County Mayo, 199 fathoms (364m); collected by NUIG in 2004 at 52°49.97'N, 12°39.83'W, 441m; 53°12.25'N, 14°39.32'W, 633m.

Eurycope ?*latirostris* collected by AFEN 1996 at 60°32.03'N, 3° 17.67'W, 314m.

Eurycope ?*latirostris* collected by SEA 1 at 59°59.74'N, 7°43.08'W, 584m; 60°55.62'N, 2°24.06'W, 342m; 60°53.23'N, 2°20.69'W, 246m.

Species name: *Disconectes phalangium* (G. O. Sars, 1864)

Eurycope phalangium G. O. Sars, 1864: 210; Wolff, 1962: 146, 257; Hult, 1941: 110.

Eurycope phallangium G. O. Sars, 1899: 147, pl. 66; Hansen, 1916: 50, pl. XIII, fig. 8a.

Disconectes phallangium Wilson and Hessler, 1981: 407–409, figs 2–3.

Type locality: Straits of Drøbak, Norway.

Type material: preparatory ♀ lectotype, ZMO F15478a. Paralectotypes: 20 additional specimens, ZMO F15478b.

Distribution: Norway, Porcupine Bank.

Records: collected by the *Helga* on the Porcupine Bank at 53°1'N, 14°34' W, 293 fathoms (536m); collected by NUIG at 53°12.25'N, 14°39.32'W, 633m.

Genus *Echinozone* G. O. Sars, 1897

Species name: *Echinozone coronata* (G. O. Sars, 1870)

Ilyarachna coronata G .O. Sars, 1870: 168.

Echinozone coronata G. O.Sars 1879: 139; pl. 61, fig. 2.

Type locality: Varanger Fjord, Vadso, Norway. 100–300 fathoms (188–565m).

Type material: ZMO (data unavailable).

Distribution: Davis Strait, Iceland, Shetland Islands, Norway, Northern Britain.

Records: collected by SEA 1 at 59°56.66'N, 7°40.98'W; 59°56.83'N, 6°59.94' W; 59.34' N, 0°18.50' E, 320-808m; by AFEN 1996 at 60°58.41'N, 2°28.26'W, 448m.

Genus *Eurycope* Sars, 1864

Species name: *Eurycope cornuta* G. O. Sars, 1864

Eurycope cornuta G. O. Sars, 1864: 209; 1897: 145; pl. 64; Hansen, 1916: 141–142 pl. XII, figs 8a–8k; Hult, 1941: 103; Wilson and Hessler, 1981: 405–406, fig. 1.

Eurycope robusta Harger, 1878, part VI: 332; pl. III, fig. 15.

Type locality: Straits of Drøbak, Norway.

Type material: preparatory ♀ lectotype, straits of Drøbak, from Sars'collection, ZMO F546a. Paralectotypes: 16 individuals, ZMO F546b.

Distribution: North-East Atlantic, Gulf of St Lawrence, south of the Faeroe Islands.

Records: *Eurycope ?cornuta* was collected by AFEN 1996 at 61°08.02'N, 2° 41.77'W, 789m.

Species name: *Eurycope producta* G. O. Sars, 1868

Eurycope producta G. O. Sars, 1868: 113; 1898: 147, pl. 65; Hansen, 1916: 147–148, pl. XIII, fig. 6a; Menzies, 1962: 141, fig. 33C–J.

Type locality: Norwegian coast from Christiana Fjord to Vadso.

Type material: ZMO (data unavailable).

Distribution: Davis Strait, Iceland, Norway, Greenland, Faeroe Islands, Ireland.

Records: collected by: the *Helga* 77 miles (124km) west of Achill Island, County Mayo at a

depth of 382 fathoms (699m); NUIG in 2004 at 52°49.971'N, 12°39.8320'W, 441m; 53°14.4606'N, 14°46.0556'W, 979m.

Eurycope ?*producta* was collected by AFEN 1996 at 61°02.55'N, 2°33.97'W, 591m.

Eurycope ?*producta* was collected by SEA 1 at 59°58.34'–61°54.96'N, 1°42.80'–6°13.68'W, 543–1279m.

Genus *Ilyarachna* Sars, 1870

Species name: *Ilyarachna antarctica* Vanhoeffen, 1914

Ilyarachna antarctica Vanhoffen, 1914: 591; Nordenstam, 1933: 256; Wolff, 1956: 106–111; Menzies, 1962: 156; Wolff, 1962: 94, 102–105; Thistle, 1980: 118–122, fig. 3.

Ilyarachna bicornis Hansen, 1916: 215; Gurjanova, 1932: 66; Menzies, 1962: 156–157; Wolff, 1962: 96, 101–102; Hessler and Thistle, 1975: 157.

Type locality: Antarctic Indian Ocean. 65°15'S, 80°19'E, 3397–3423m, -0.3°C.

Type material: ♀ lectotype designated by Wolff (1956).

Distribution: Antarctic, Kermadec Trench (Galathea stations), Porcupine Bank.

Records: collected by WHOI in 1969 on the Porcupine Abyssal Plain at 50°04.9'N, 14°23.8'W, 3859m.

Species name: *Ilyarachna longicornis* (G. O. Sars, 1864)

Ilyarachna longicornis G. O. Sars, 1864: 212; Meinert, 1890: 196; G. O. Sars, 1899: 136, pl. LIX; Hult, 1941: 97–100.

Ilyarachna hirticeps G. O. Sars 1869: 167; Hult, 1941: 97; Menzies, 1962: 157–158, fig. 45e–h; Thistle, 1980: 129–130, fig. 9a–b.

Ilyarachna plunketti Tattersall, 1905: 28–29, pl. VII, figs 1–9.

Type locality: Skager Rak, Norway.

Type material: ♀ holotype by original designation. ?Type, ZMO F19145.

Distribution: North Atlantic, Arctic Ocean.

Records: collected by WHOI in 1969 from the Porcupine Abyssal Plain at 51°32.2'N,

12°35.9'W, 1500–1491m; 50°12.3'N, 13° 35.8'W, 2868–2890m; 50°08.3'N, 13°53.7'W, 3338–3856m; 50°04.9'N, 14°23.8'W, 3859m; collected by NUIG in 2004. 52°49'N, 12°39'W, 441m..

Ilyarachna ?*longicornis* collected by AFEN 1996 at 60°02.15'N, 4°54.56'W, 415m.

Ilyarachna ?*longicornis* collected by SEA 1 at 59–61°38.8'N, 4–8°W, 584–1380m.

Species name: *Ilyarachna polita* Bonnier, 1896

Ilyarachna polita Bonnier, 1896: 608; Wolff, 1962: 96; Hessler and Thistle, 1975: 157; Thistle, 1980: 133–135.

Ilyarachna simplex Menzies, 1962: 160; Wolff, 1962: 95; Hessler and Thistle, 1975: 157.

Ilyarachna thori Wolff, 1962: 97–100; Hessler and Thistle, 1975: 157.

Type locality: Bay of Biscay, 216–4885m.

Type material: holotype, ZMUC CRU-8388.

Distribution: Porcupine Abyssal Plain, Bay of Biscay.

Records: collected by WHOI on the Porcupine Abyssal Plain at 50°04.9'N, 14°23.8'W, 3859m.

Species name: *Ilyarachna triangulata* Menzies, 1962

Ilyarachna triangulata Menzies, 1962: 161–162, fig. 49d-e; Wolff, 1962: 94; Hessler and Thistle, 1975: 157; Thistle, 1980: 138–140, fig. 14.

Type locality: South Atlantic, L. G. O. Biotrawl no.14, 30°14.9'S, 13°03'E, 3049m.

Type material: ♀ holotype by original designation, AMNH 12084.

Distribution: South Atlantic, Porcupine Abyssal Plain.

Records: collected by Woods Hole Oceanographic Institute on the Porcupine Abyssal Plain at 50°04.7N–50°43.5'N, 13°35.8'W–17°51.7'W, 2868–4632m.

Genus *Lipomera* (*Lipomera*) Tattersall, 1905

Species name: *Lipomera* (*Lipomera*) *lamellata* Tattersall, 1905

Lipomera lamellata Tattersall, 1905: 32–35, pl. viii.

Lipomera (*Lipomera*) *lamellata* Wilson, 1989: 55, fig. 18.

Type locality: collected by the *Helga* 60 miles (97km) west of Achill Head, County Mayo, 199 fathoms (364m).

Type material: none designated, both ♂♀ specimens described.

Distribution: recorded from the type locality only.

Records: type locality.

Genus *Munnopsis* M. Sars, 1861

Species name: *Munnopsis beddardi* (Tattersall, 1905)

Munnopsides beddardi Tattersall, 1905: 26, 73, pl. VI, figs 1–8.

Pseudomunnopsis beddardi Hansen, 1916: 160–162, pl. VI, figs 1–8.

Munnopsis beddardi Wolff, 1962: 188–189, figs 118–119.

Type locality: 60–77 miles (124km) west of Achill Island, County Mayo, at a depth of 199–382 fathoms (364–699m).

Type material: unknown.

Records: type locality.

Species name: *Munnopsis typica* M. Sars, 1861

Munnopsis typica M. Sars, 1861: 84; 1868: 310, plates. VI–VII; Hansen, 1887: 196, pl. XX, figs 2–2e; Meinert, 1890: 196; G. O. Sars, 1897: 133, plates. 57–58; Richardson, 1905: 486, figs 544–546; Hansen, 1916: 156–157; Wolff, 1962: 188–189, figs 118–119; Svavarsson, 1988B: 101.

Type locality: coast of Norway, from Christiana Fjord to Vadso, 60–400 fathoms (113–753m).

Type material: ZMO (data unavailable).

Distribution: North Atlantic Ocean.

Records: collected by the AFEN 1996, 61°10.51'N, 2°45.29'W, 979m.

Genus *Munnopsurus* Richardson, 1912

Species name: *Munnopsurus longipes* (Tattersall, 1905)

Eurycope longipes Tattersall, 1905: 30–32, pl. X, figs 1–8.

Munnopsurus longipes Richardson, 1912: 4; Hansen, 1916: 136, pl. XII, 6a–6b; Monod, 1926: 21; Wolff, 1962: 151–153, figs 92–93, pl. IX B–C.

Type locality: no type locality is stated, but descriptions are based on specimens taken by the *Helga*, described below.

Type material: One ♂ described; ♀ description from several ♀♀, largest of which is 10mm. No types designated and no material deposited in the National Museum of Ireland.

Distribution: West of Ireland, Porcupine Bank.

Records: collected by the *Helga* 50 miles (81km) west-north-west of Tearaght, County Kerry, at a depth of 350 fathoms (640m), and 54 miles (87km) west-north-west of the same location at 454 fathoms (830m); collected by NUIG in 2004 at 53°14'N, 14°55'W, 1564m.

Genus *Munneurycope* Stephensen, 1912

Species name: *Munneurycope murrayi* (Walker, 1903)

Munnopsis? murrayi Walker, 1903: 227, pl. XVIII, figs 1–6.

Munnopsis murrayi Tattersall, 1905: 24, 73, pl. V, fig. 8; 1911: 190, figs 8–14.

Munneurycope tjalfiensis Stephensen, 1913: 99, figs 6–8; 1915: 23, figs 12–13.

Eurycope murrayi Hansen, 1916: 137, pl. XII, 7a–b; Gurjanova, 1932: 72, pl. XXVI, 105; Stephensen, 1936: 11, fig. 4; Barnard, 1936: 188, fig. 18; Tchindonova, 1959: 173, figs 1 and 4; Menzies, 1962: 141, fig. 34M.

Munneurycope murrayi Wolff, 1962: 157–161, figs 94–97, pl. IX D.

Type locality: not designated. Material recorded from one of the following stations from the west coast of Ireland: 52°27.6'N, 15°40'W, 920–1470 fathoms (1682–2688m); 52°18'N, 15°53'W, 1410–1710 fathoms (2578–3127m).

Type material: no type material designated. Seven specimens collected by Walker, which he described as 'probably all males'. Non-type material collected by Trans. Fisheries deposited in the National Museum of Ireland, from 450 fathoms (823m).

Distribution: West of Ireland, Porcupine Bank.

Records: collected by the *Helga* 40–50miles (64–81km) north by west of Eagle Island, County Mayo. 54 miles (87km) west-north-west of Teaghart, County Kerry, at a depth of 350–454 fathoms (640–830m); outside the Porcupine Bank at a depth of 700 fathoms (1280m).

Genus *Paramunnopsis* Hansen, 1916

Species name: *Paramunnopsis oceanica* (Tattersall, 1905)

Munnopsis oceanica Tattersall, 1905: 23, 72, pl. V, figs 1–7; 1911: 187, with figures; Vanhoffen, 1914: 581, figs IIa–b (? and IIc–d).

Paramunnopsis oceanica Hansen, 1916: 155, pl. XIII, figs IIa–Iii, pl. XIV, figs 1a–1b.

Type locality: 40–50 miles (64–81km) west by north of Eagle Island, County Mayo**,** 750–1150 fathoms (1370–2100m).

Type material: unknown.

Distribution: North Atlantic, South Atlantic, Sub-Antarctic Ocean (dubious record by Vanhoeffen (1903).

Records: type locality.

Genus *Tytthocope* Wilson and Hessler, 1981

Species name: *Tytthocope megalura* (G. O. Sars, 1872)

Eurycope megalura G. O. Sars, 1872: 274; 1899: 151; Tattersall, 1905: 75; Nierstrasz and Stekhoven, 1930: 125; Gurjanova, 1933: 424; Wolff, 1962: 146, 261.

?*Eurycope megalura* Hansen, 1916: 148.

Tytthocope megalura Hessler and Wilson, 1981: 412–415.

Type locality: the outer part of Hardanger Fjord at Mosterhavn, Norway, 267–355m.

Type material: juvenile ♀ lectotype, ZMO F15332a. Brooding ♀ paralectotype, ZMO F15332b.

Distribution: southwestern Norway; Hardanger, Stavanger, and Hjelte Fjords; west of Ireland, Porcupine Bank and south west of Iceland.

Records: collected by the *Helga* 60 miles (97km) west of Achill Head, County Mayo, 199

fathoms (364m); collected by NUIG in 2004 at 52°49.97'N, 12°39.83'W, 441m; 53°15.12'N, 14°50.43'W, 1208m; 53°12.25'N, 14°39.32'W, 633m.

Eurycope ?*megalura* collected by AFEN 1996 at 61°37.34'N, 1°47.11'W, 1072m.

Eurycope ?*megalura* collected by SEA 1 at 59°59.74'N, 7°43.08'W, 584m; 61°36.82'N, 1°58.80'W, 1279m; 61°37.80'N, 1°45.72'W, 1053m; 61°54.96'N, 2°48.06'W, 1624m.

FAMILY ISCHNOMESIDAE HANSEN, 1916

Genus *Gracilimesus* Kavanagh and Wilson, 2007

***Species name**: *Gracilimesus celticensis* (Kavanagh *et al.*, 2006) **New to Ireland**

Haplomesus celticensis, Kavanagh *et al.*, 2006: 14–21, figs 8–12.

Gracilimesus celticensis Kavanagh and Wilson, 2007: 519.

Type locality: the Celtic Sea, off the west coast of Ireland. 51°32.2'N, 12°35.9'W 1491–1500m; WHOI station 313 August 1972, using a large epibenthic sled.

Type material: ♀ holotype. Paratypes: ♂, AM P.71659; juvenile ♂, AM P.71660; manca ♂, AM P.71661, same locality; additional paratypes 49 ind., AM P.71662–P.71667, same locality as holotype.

Distribution: recorded only from type locality.

Records: type locality.

***Species name**: *Gracilimesus* cf. *gorbunovi* (*sensu* Svavarsson, 1984) **New to Ireland**

Haplomesus ?gorbunovi Svavarsson, 1984: 31, fig. 5–6.

Gracilimesus gorbunovi Kavanagh and Wilson, 2007: 520.

Type locality: not available (specimens collected in the Norwegian Sea).

Type material: not available.

Records: collected by NUIG at 53°00'N, 15°59'W, 3283m; 52°49.97'N, 12°39.83'W, 441m; collected by SEA 1 at 61°33.36'N–61°54.96'N, 1°55.40'W–3°06.96'W, 1202–1582m.

Remarks: *Haplomesus gorbunovi* Gurjanova, 1946 differs from specimens collected by J. Svavarsson in several respects. According to Svavarsson (1984) these differences can be

explained by the different size of the specimens and errors in Gurjanova's (1946) descriptions and illustrations. The specimens collected by NUIG and SEA 1 are the same species as collected by Svavarsson; whether these are the same species as described by Gurjanova is unclear at the moment (Kavanagh and Wilson, 2007).

***Species name**: *Gracilimesus modestus* (Hansen, 1916) **New to Ireland**

Haplomesus modestus Hansen, 1916: 65–66 pl.V, fig. 5, a–b; Gurjanova, 1932: 44; 1933: 410; Wolff, 1962: 72, 86, 87, 88, 217, 265, fig. 40, pl. III B-C; Menzies, 1962: 119, fig. 20e; Kussakin, 1988: 449–450, fig. 369.

Gracilimesus modestus Kavanagh and Wilson, 2007: 523.

Type locality: Davis Strait. *Ingolf* station 24, 63°06'N, 56°00'W, 1199 fathoms (2258m).

Type material: immature ♀ holotype, ZMUC CRU-7359.

Distribution: Davis Strait, Porcupine Bank.

Records: collected by NUIG at 54°08.02'N, 13°59.82'W, 2765m.

Genus *Heteromesus* Richardson, 1908

Species name: *Heteromesus greeni* (Tattersall, 1905)

Ischnosoma greeni Tattersall, 1905: 20–22, 72, pl. IV, figs 1–6.

Heteromesus greeni (Tattersall). Richardson, 1908: 81; Wolff, 1962: 86, 217, 260, 274; Kussakin, 1988: 483–485, fig 397.

Type locality: 60–77 miles (97–124km) west of Achill Head, County Mayo. Approximately 54°N, 11°W, 199–382 fathoms (364–699m).

Type material: ♀ holotype, NHM 1911.11.8.9599.

Distribution: West of Ireland, Porcupine Seabight.

Records: type locality; collected by NUIG at 50°55'N–54°09'N, 13°59'W–14°55'W, 1018–2200m.

Species name: *Heteromesus longiremis* Hansen, 1916

Heteromesus longiremis Hansen, 1916: 68–69, pl.VI, fig. 2a–f; Gurjanova, 1932: 45, tabl. XV, 55; Menzies, 1962: 122, fig. 22A–B; Wolff, 1962: 85, 217, 262, 275, 289; Kussakin, 1988: 481–483, fig. 394–396.

Type locality: North Atlantic: Davis Strait. *Ingolf* station 36, 61°50'N, 56°21'W, 2702m.

Type material: syntypes, ZMUC CRU-7130. This type material is now missing (Cunha and Wilson, 2006).

Distribution: North Atlantic.

Records: collected by NUIG at 52°59'N, 14°54'W; 50°54'N, 14°35'W, 1018–1022m; collected on the Noratlante Expedition by Pierre Chardy at 52°10'N–61°50'N, 23°00'W–56°21'W, 2624–4100m.

***Species name**: *Heteromesus spinosus* (Beddard, 1886) **New to Ireland**

Ischnosoma spinosum Beddard, 1886: 40–42, pl. VI, fig. 1–5.

Heteromesus spinosus (Beddard) Richardson, 1908: 81.

Type locality: North Atlantic, off the Azores. 37°26'N, 25°13'W, 1829m.

Type material: ♀ holotype, NHM: 89.4.27.52.

Distribution: North Atlantic.

Records: collected by NUIG at 52°59'N, 14°54'W; 53°00'N, 15°22'W, 1022–2770m.

Genus *Ischnomesus* Richardson, 1908

***Species name**: *Ischnomesus armatus* Hansen, 1916 **New to Ireland**

Ischnomesus armatus Hansen, 1916: 57–58, pl. IV, figs 6a–6f; Menzies, 1962: 113, fig. 16j; Kussakin, 1988: 436, fig. 359.

Type locality: Davis Strait. *Ingolf* station 36, 61°50'N, 56°21'W, 1435 fathoms (2702m).

Type material: ♂ holotype, ZMUC CRU–5623.

Distribution: North Atlantic, Davis Strait, Rockall Trough.

Records: collected by NUIG at 53°00'N, 15°22'W, 2770m.

Species name: *Ischnomesus bispinosus* (G. O. Sars, 1868)

Ischnosoma bispinosum G. O. Sars, 1866: 34; Meinert, 1890: 194; G. O. Sars, 1897: 123, pl. 52; Tattersall, 1905: 71.

Ischnomesus bispinosus (G. O. Sars). Richardson, 1908: 81; Hansen, 1916: 55, 57; Gurjanova, 1932: 42–43, tabl. XIV, 48; Menzies, 1962: 112–113, fig. 16 E–I; Wolff, 1962: 74, 257, 274; Kussakin, 1988: 420, fig. 347.

Type locality: Christiana Fjord.

Type material: ♂♀, ZMO (data unavailable).

Distribution: North Atlantic.

Records: collected by the *Helga* 77 miles (124km) west of Achill Island, County Mayo, at a depth of 382 fathoms (699m); collected by GMIT at 54° 34'N, 11° 05'W, 351m; 54° 33'N, 11° 06W, 347m; 54° 33'N, 11° 07'W, 344m.

Ischnomesus ?*bispinosus* collected by AFEN1996 at 61°26.45'N, 2°15.53' W, 1163m.

Ischnomesus ?*bispinosus* collected by SEA 1 at 59°46'N, 8°27'W; 59°54'N, 7°39'W; 59°56'N, 6°59'W, 598–1092m.

FAMILY JANIRIDAE G. O. SARS, 1897

Genus *Janira* Leach, 1814

Species name: *Janira maculosa* Leach, 1814

Ianira maculosa Leach, 1814: 435.

Henopomus muticus Kroyer, 1846, pl. 30, figs. 1a–1h; Kroyer, 1847: 366.

Ianira maculosa G. O. Sars, 1897: 99, 40; Hansen, 1916: 14–15, pl.I, figs 1a–1f.

Type locality: Greenland.

Type material: unknown.

Distribution: widespread in the North-East Atlantic.

Records: collected by the *Helga* off the coasts of Counties Antrim Galway, Kerry and Mayo and, on the Porcupine Bank from depths of 118–388 fathoms (216–710m); collected by SEA 1 from 59°50.99–60°59.44'N, 2°29.52'–4°43.08'W, 201–967m; collected by SEA 4 from 60–

62°N, 0–2°W, 300–454m; collected by AFEN 1996 from 60°55'N, 2°24'W, 341m.

Genus *Ianiropsis* Sars, 1897

Species name: *Ianiropsis breviremis* (G. O. Sars, 1882)

Janira breviremis G. O. Sars, 1882: 64.

Ianiropsis breviremis G. O. Sars 1897: 102–103, pl. XLII; Tattersall, 1905: 69; Zirwas, 1910: 93; Nierstrasz and Stekhoven, 1930: Stephensen, 1948: 76; Menzies, 1951: 153–155; Holthuis, 1956: 110; Wolff, 1962: 254; Gruner, 1965: 138–142; Kussakin, 1988: 90.

Type locality: North East Atlantic, 0–210m.

Type material: ZMO (data unavailable).

Distribution: coast of Norway, West of Ireland.

Records: collected by the *Helga* 70 miles (124km) south west of Fastationet Rock at a depth of 70 fathoms (128m).

FAMILY JANIRELLIDAE MENZIES, 1956

Genus *Janirella* Bonnier, 1896

Species name: *Janirella priseri* Chardy, 1972

Janirella priseri Chardy, 1972: 11–17, figs A–L.

Type locality: 55°52'5N, 49°53'4W, 3465m.

Type material: ♂ holotype, MNHN.

Distribution: North Atlantic Ocean, 2456–4166m.

Records: collected by SMBA at their permanent station in the Rockall Trough, 54°40' N, 12°17.5'W, 2900m.

FAMILY MACROSTYLIDAE HANSEN, 1916

Genus *Macrostylis* G. O. Sars, 1864

Species name: *Macrostylis magnifica* Wolff, 1962

Macrostylis magnifica Wolff, 1962: 91–93, pl. IV A–B, fig. 43.

Type locality: south of the Davis Strait. *Ingolf* station 38, 59°12'N, 51°05'W, 352m. Bottom temperature 1.3°C.

Type material: pereonites 5–7 and pleon of ♀ holotype.

Distribution: recorded from the type locality, and the station below.

Records: collected by NUIG in February 2003 at 53°00'N, 15°22'W 2770m; collected by SMBA at their 'permanent station' in the Rockall Trough, 54°40'N, 12°17.5'W, 2900m.

***Species name**: *Macrostylis spinifera* G. O. Sars, 1864 **New to Ireland**

Macrostylis spinifera G. O. Sars, 1864: 219; G. O. Sars, 1897: 121, pl. 51; Hansen, 1916: 76–77, pl. VI, figs 6a–6c, pl. VII, figs 1a–1c; Wolff, 1962: 92, fig. 44.

Type locality: Norwegian Sea.

Type material: ZMO (data unavailable).

Distribution: widespread in the North-East Atlantic.

Records: collected by NUIG at 53°15'N, 14°50'W, 1208m over a substrate of gravelly sand; collected by AFEN 1996 at 61°03'N, 2°24'W, 542m.

***Species name**: *Macrostylis subinermis* Hansen, 1916 **New to Ireland**

Macrostylis subinermis Hansen, 1916: 80, 81, pl. VII, figs 4a–4h; Wolff, 1962: 91.

Type locality: not designated, but taken from one of the 5 Danish *Ingolf* stations from around Iceland and the Faeroe Islands below.

Type material: syntypes, ZMUC CRU-8301–8306.

Distribution: Iceland: *Ingolf* station 102: 66°23'N, 10°26'W, 750 fathoms (1412m); *Ingolf* station 103: 66°23'N, 8°52'W, 579 fathoms (1090m); *Ingolf* station 119: 67°53'N, 10°19'W, 1010 fathoms (1902m); *Ingolf* station 125: 68°08'N, 16°02'W, 729 fathoms (1372m); north of the Faeroes, *Ingolf* station 139: 63°36'N, 7°30'W, 702 fathoms (1322m); Porcupine Bank.

Records: collected by NUIG in February 2004 at 53°29'N, 16°15'W, 2800m.

FAMILY PARAMUNNIDAE G. O. SARS, 1899

Genus *Metamunna* Tattersall, 1905

Species name: *Metamunna typica* Tattersall, 1905

Metamunna typica Tattersall, 1905: 70–71, pl. IX, figs 1–3.

Type locality: not designated, but taken from one of the localities below.

Type material: unknown.

Distribution: as for Irish Records (below).

Records: collected by the *Helga* 50 miles (81km) west north west of Cleggan Head, County Galway, 120 fathoms (219m) and on the Porcupine Bank at 53°20'N, 13°W, 164 fathoms (300m).

Genus *Paramunna* G. O. Sars, 1866

Species name: *Paramunna bilobata* G. O. Sars, 1866

Paramunna bilobata G. O. Sars, 1866: 112 ; 1889: 111, plate 47, fig. 1; Wilson, 1980: fig. 1A, D. E. Kusakin, 1988: 330; Just, 1990: fig. 1A.

Type locality: Vallø, outer west coast of Oslo Fjord, Norway (~59°20'N, 11°W). Sars (1866) also mentioned a single specimen from Lofoten, Norway (~68°N, 13°W).

Type material: no holotype designated and no type material deposited.

Distribution: southern and western Norway, west coast of Sweden, Kattegat, North Sea, West of Ireland, Faeroe Islands.

Records: collected by the *Helga* 50miles (81km) west-north-west off Cleggan Head at a depth of 120 fathoms (219m); collected by AFEN 1996 at 60°44'N, 2°35'W, 148m.

Genus *Pleurogoniuim* G. O. Sars, 1864

Species name: *Pleurogonium inerme* G. O. Sars, 1882

Pleurogonium inerme G. O. Sars, 1882: 67, pl. II, fig. 5; Meinert, 1890A: 193; G. O. Sars, 1897: 114, pl. 48, fig. 1; Hansen, 1916: 43–44, pl. III, figs 8a–8b; Kussakin, 1988: 348.

Type locality: west coast of Norway, 60–150 fathoms (113–282m).

Type material: ZMO (data unavailable).

Distribution: Britain, Denmark, Ireland, North Sea and Norway.

Records: collected by the *Helga* 60 miles (97km) west of Achill Head, County Mayo, at a depth of 199 fathoms (364m); collected by AFEN 1996 at 61°10.51'N, 2°45.29'W, 979m; collected by SEA 4 at 61–62°N, 0–2°W, 803–1094m.

***Species name**: *Pleurogonium pulchrum* Hansen, 1916 **New to Ireland**

Pleurogonium pulchrum Hansen, 1916: 46–47, pl. III, figs 12a–12e; Kussakin, 1988: 351.

Type locality: west of Iceland. *Ingolf* station 8, 63°56'N, 24°40'W, 136 fathoms (256m), temperature 6°C.

Type material: ♀ holotype, ZMUC CRU–7894.

Distribution: North-East Atlantic.

Records: collected by NUIG at 53°15'N, 14°50'W, 1208m on a substrate of gravelly sand.

Species name: *Pleurogonium rubicundum* (G. O. Sars, 1864)

Pleuracantha rubicunda G. O. Sars, 1864: 220.

Pleurogonium rubicundum G. O. Sars, 1897: 113, pl. 47, fig. 2; Hansen, 1916: 45–46, pl. III, figs IIa-IIb; Kussakin, 1988: 338.

Type locality: Norwegian coast, from Christiana Fjord to Vadso, 6–30 fathoms (11–56m).

Type material: ♀ holotype, ZMO (data unavailable).

Distribution: North East Atlantic including Ireland (shallow water).

Records: collected by SEA 4 at 61°52'N, 1°14'W, 753m; collected by AFEN 1996 at 61°08'N, 2°41'W, 789m.

FAMILY MUNNIDAE G. O. SARS, 1899

Genus *Munna* Kroyer, 1839

Species name: *Munna fabricii* Kroyer, 1846

Munna fabricii Kroyer, 1846, pl. XXXI, fig. 1a–1q; 1847: 380; Meinert, 1890A: 193; Hansen, 1916: 211, pl. III, figs 1a–1e; Hansen, 1916: 38–39, pl. III, figs 5a–5d; Carton, 1962: 236–238,

pl. VIII; Kussakin, 1988: 306.

Type locality: Norway, 0–366m.

Type material: syntypes, ZMUC CRU-6386, 6387.

Distribution: widespread in the North East Atlantic including Ireland (shallow water records only).

Records: *Munna* ?*fabricii* collected by AFEN 1996 at 60°40'N, 3°03'W.

Species name: *Munna kroyeri* Goodsir, 1842

Munna kroyeri Goodsir, 1842: 365, pl. VI, fig. 6 (*teste* Sars); G. O. Sars, 1897: 109, pl. 46, fig. I; Hansen, 1916: 37–38, pl. III, figs 4a–4b; Carton, 1962: 234–236, pl. VII–VIII; Kussakin, 1988: 292.

Type locality: the mouth of the Firth of Forth, shallow water.

Type material: one specimen described, sex and location of material unknown.

Distribution: North East Atlantic.

Records: collected by the *Helga* off Rathlin Island, County Antrim, at a depth of 115 fathoms (210m); also collected in shallow water samples.

Munna ?*kroyeri* collected by AFEN 1996 at 60°57'N, 2°24'W, 408m.

Species name: *Munna limicola* G. O. Sars, 1867

Munna limicola G. O. Sars, 1867: 108, pl. XLV, fig. 1.

Munna limicola Carton, 1962: 232–234, pl. V–VI.

Type locality: Christiana Fjord, 60–300 fathoms (113–565m). Muddy bottom type.

Type material: ♀ holotype, location unknown.

Records: collected by the *Helga* at the Porcupine Bank at 53°1'N, 14°34'W, 293 fathoms (536m).

FAMILY NANNONISCIDAE HANSEN, 1916

Genus *Nannoniscus* G. O. Sars, 1870

***Species name**: *Nannoniscus oblongus* G. O. Sars, 1870 **New to Ireland**

Nannoniscus oblongus G. O. Sars, 1870: 164; 1897: 119, pl. 50; Hansen, 1916: 92–94, pl. VIII, figs 4a–f; Menzies, 1962: 136–137, figs. 31I–K.

Type locality: off the Lofoten Islands, at Skraaven, Norway, 225–468m.

Type material: unknown.

Records: collected by NUIG in 2004 at 53°14'N, 14°46'W, 978.7m; 53°12.25'N, 14°39.32'W, 633m; collected by SEA 1 at 60°59'N, 2°29' W, 495m.

FAMILY PSEUDOMESIDAE HANSEN, 1916

Genus *Pseudomesus* Hansen, 1916

***Species name**: *Pseudomesus brevicornis* Hansen, 1916 **New to Ireland**

Pseudomesus brevicornis. Hansen, 1916: 74, pl. IV, figs 5a–5g.

Type locality: north of Iceland. *Ingolf* station 102: 66°23'N, 10°26'W, 750 fathoms (1412m), temperature 0.9°C.

Type material: syntype. ZMUC-CRU 87.

Distribution: Iceland, Porcupine Bank.

Records: collected by NUIG in October 2003 at 53°00'N, 15°22'W, 2770m; 54°08'N, 13°59'W, 2200m.

FAMILY THAMBEMATIDAE STEBBING, 1912

Genus *Thambema* Stebbing, 1912

Species name: *Thambema amicorum* Stebbing, 1912

Thambema amicorum Stebbing, 1912: 42; 1913: 231, 237–239, 246, p. XXVI; Bocquet and Lévi, 1955: 133; Birstein, 1961: 135–136, 139–140; Menzies, 1962: 184, fig. 63; Wolff, 1962: 264; Schiecke, 1975: 169–175; Harrison, 1987: 54–59, figs 1–4; Kussakin, 1988: 18–20, figs 1–3.

Type locality: North Atlantic, west of County Donegal. *Porcupine* Station 19, 54°53'N, 10°56'W, 2486m.

Type material: unknown.

Distribution: Rockall Trough.

Records: collected by SMBA at their permanent station in the Rockall Trough, 54°40'N, 12°17.5'W, 2900.

Species name: *Thambema fiatum* Harrison, 1987

Thambema fiatum Harrison, 1987: 68–72, figs 13–15.

Type locality: Hebridean Slope, Rockall Trough. SMBA station 63, 56°37'N, 09°49'W, 1800m.

Type material: ♂ holotype, NHM reg. no. 1986:126:1. Paratypes: ♀ from the same location as the holotype, NHM 1986:126: 1; adult ♂ and ovigerous ♀ from SMBA station 68, 58°42'N, 09°43'W, 1800m, 1986: 127: 2.

Distribution: continental slope west of the Hebrides, and northern Rockall Trough.

Records: type localities.

Species name: *Thambema golanachum* Harrison, 1987

Thambema golanchum Harrison, 1987: 59–63, 70, figs 5–8.

Type locality: Southern Rockall Trough. SMBA Station 46, 55°04'N, 12°06'W, 2875m.

Type material: adult ♂ holotype, NHM reg. no. 1956: 114: 1. Paratypes collected from 9 additional stations:- SMBA station 10, 56°37' N, 11°04' W, 2540m, NHM reg. no. 1986: 118: 2; SMBA station 34, 56°36'N, 11°30'W, 2515m, 1986: 115: 1; SMBA station 46, permanent station at 2900m, 1986; 116: 1; SMBA station 47, permanent station at 2900m, 1986: 117: 2; SMBA station 61, 57°08'N, 12°09'W, 2000m; 1986: 119:3 and1986: 120:1; SMBA station 64, 56°38'N, 09° 29'W, 1400m, 1986: 121: 1; SMBA station 150, permanent station at 2900m, 1986: 122: 1; SMBA station 155, 48°27'N, 10°20'W, 1330m, 1986: 123: 1; SMBA station 185, permanent station at 2900m, 1986: 124: 1; 9 adult ♂♂, 4 non-ovigerous ♀♀ and 1 manca specimen.

Distribution: Southern Rockall Trough, continental slope of the Celtic Sea, 1330–2916m.

Records: type localities.

Species name: *Thambema tanum* Harrison, 1987

Thambema tanum Harrison, 1987: 64–67, 71, figs 9–12.

Type locality: Southern Rockall Trough. SMBA station 48, 55°04'N, 12°04'W, 2875m.

Type material: adult ♂ holotype, NHM reg. no. 1986: 113: 1.

Distribution: north-east of Porcupine Bank.

Records: type locality.

INCERTAE SEDIS

Genus *Tole* Ortmann, 1901

***Species name:** *Tole laciniata* (G. O. Sars, 1872) **New to Ireland**

Janira laciniata G. O. Sars, 1872: 92.

Ianthe laciniata G. O. Sars, 1897: 101, pl. 41.

Ianira laciniata Hansen, 1916: 20–21, pl. I, fig. 5a.

Tole laciniata Ortmann, 1901: 157.

Type locality: Storeggen Bank, off Molde, Norway, 400 fathoms (753m).

Type material: ZMO (data unavailable).

Distribution: Davis Strait, Norway, Denmark, British Isles.

Records: collected by NUIG at 53°14.46'N, 14°46'W, 978.7m; collected by SEA 1 at 59°56.66'N–61°02.65'N, 2°29.52'W–7°45.12'W, 492–677m; collected by AFEN 1996 at 60°58.41'N, 2°28.26'W, 448m.

Discussion

The asellote fauna of the study area is comprised of 13 families, 31 genera and 73 species. Eight of the species listed above are new Irish records, and six of these are also new to the territorial waters of the British Isles as a whole. A total of 15 new species of Asellota, as yet undescribed, were also collected by NUIG including one new species of *Dendrotion* (Asellota: Dendrotionidae); two new species of *Janirella* (Asellota: Janirellidae); one new species of *Macrostylis* (Asellota: Macrostylidae); nine new species of *Eurycope* (Asellota:

Munnopsididae) and two new species of *Paramunna* (Asellota: Paramunnidae). The depth ranges of the species recorded are shown in table 2. This range is likely to be affected by sampling bias, with several species having been collected at only one station.

The most speciose family in the study area is the Munnopsidae, with 18 described species and seven new species (see Table 3). Wilson's (1989) classification of the Munnopsidae included the former families Ilyarachnidae and Eurycopidae in the family, a revision which has significantly increased its diversity. The Haploniscidae are also speciose, with 11 species in the study area. This reflects the large amount of work carried out by Lincoln in 1985, in which he described eight of these 11 species. The most speciose genus is *Haploniscus* with eight described species. A total of 58% of all the genera recorded (19) are represented by only one species, and 74% of the genera (23) are represented by one or two species. A similar situation occurs in the Northern Seas (Norwegian, Greenland, Icelandic and Arctic seas) where 55% of genera have a single species, and 70% of genera have one or two species (Svavarsson *et al.*, 1993).

The species recorded in this area of the North East Atlantic bear an affinity to the fauna of the Northern Seas. Svavarsson *et al.* (1993) noted that the arctic deep-sea fauna is characterized by genera and species predominantly of an Atlantic origin. It is thought that this fauna consists of comparatively recent immigrants from the adjacent shelves (Dahl, 1972, 1979; Dahl *et al.*, 1976; Just, 1980; Hessler and Wilson, 1983). A connection between the North Atlantic and the Norwegian-Greenland seas has existed since the opening of the Norwegian sea, *via* a shallow (0.8km) water connection in the region of the Faeroe channel. Forty percent of the species recorded in the study area are also found in the Northern Seas, while thirty percent of the species recorded in the Northern Seas have been collected in the study area. The deeper opening from the Atlantic compared with the Pacific into the Northern Seas has allowed northern Atlantic species to enter to a greater extent (Svavarsson *et al.*, 1993). The Northern Seas contain 12 asellotan families, two of which, Katianiridae and Acanthaspidiidae, are not recorded from the study area. Three families from the study area, Janirellidae, Thambematidae and Pseudomesidae, are not recorded from the Northern Seas (Svavarsson *et al.*, 1993). Although

the overall diversity in the study area is similar to that observed in more northerly waters, there is a higher proportion of pronounced deep-sea families. In particular, the Haploniscidae and Ischnomesidae display greater diversity in terms of species, while the Haploniscidae also have a higher number of genera recorded in the study area. Harrison (1987) found that the families Haploniscidae, Ischnomesidae and the subfamilies Ilyarachnidae and Eurycopidae together provided approximately 77% of the collection (by numbers of individuals) from 19 epibenthic sled samples collected from 1973–1983 at one site in the southern Rockall Trough. In the area sampled by NUIG (see Figure 1), these taxa account for 57% of the collection by numbers of individuals (Table 4). This figure is lower than that observed in the Rockall Trough due to the shallow stations sampled across the Porcupine Bank. The family Paramunnidae account for approximately 15% of the specimens collected. However, these specimens were collected from two stations only, with one genus and three species (two sp. nov.).

Several species recorded in the study area support the theory of subsequent emergence of asellote isopods in northern latitudes. *Pseudomesus brevicornis* is recorded from 1412–2770m in the study area, while in the Arctic Ocean it occurs in waters as shallow as 80m (Svavarsson *et al*., 1993). *Ischnomesus bispinosus* is recorded in the study area from 300–700m, while in the Arctic Ocean it has been recorded in water as shallow as 10–531m. *Desmosoma lineare* is found at depths of 699–1564m in the study area, and depths of 17–531m in the Northern Seas. *Eurycope producta* has a range of 441–979m in the study area compared to 72–1260m in the Arctic sea. Although this catalogue focuses on areas from 100–5000m, none of the species listed above are recorded from shallower waters in the study area.

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FIGURE 1. Map of study area with stations from dedicated surveys aboard the RV Celtic Explorer 2003-2004.

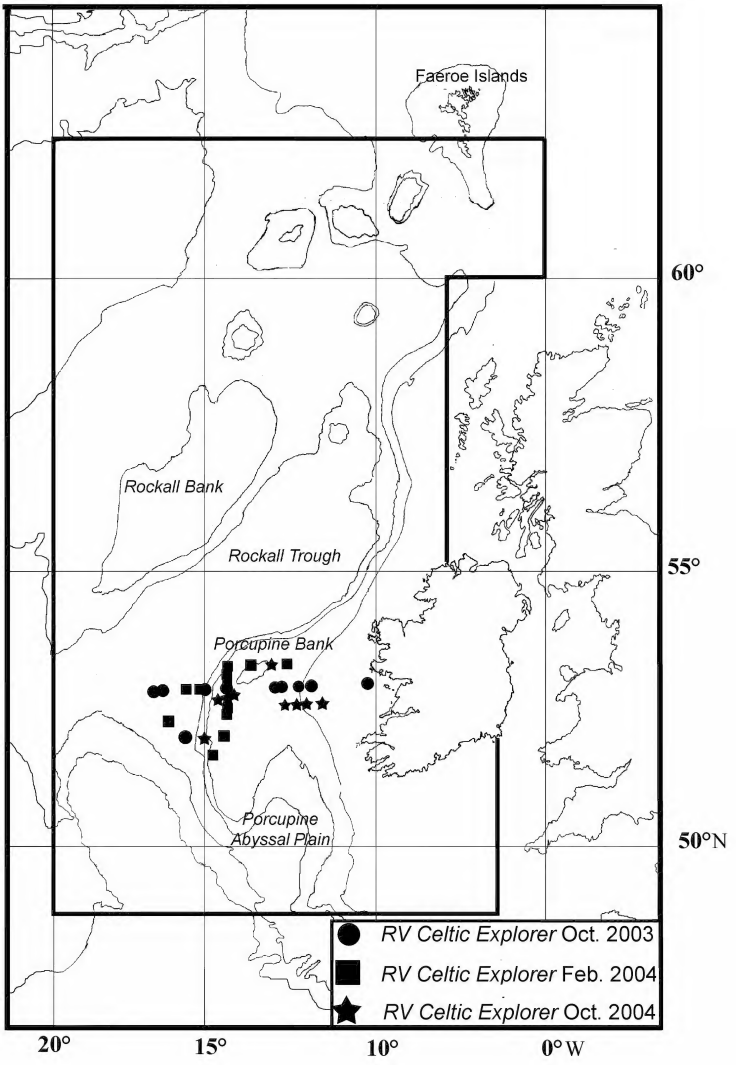

TABLE 1. Benthic sampling projects carried out in the North East Atlantic study area.

COUNTRY	PROJECT	DATES	STUDY AREA	PURPOSE	RELEVANT PUBLICATIONS
UK (Ireland)	*HMS Lightning*	1868	Shetland Islands	Faunal survey comprising dredge sampling.	Thompson, 1873; Carpenter, 1868.
UK (Ireland)	*HMS Porcupine*	1869-1870	British Isles including Porcupine Bank, Rockall Trough, Rockall Bank	Faunal survey comprising dredge sampling.	Carpenter and Thompson, 1870; Carpenter and Jefferys, 1871; Thomson, 1873.
UK (Ireland)	*HMS Challenger*	1872–1876	World's oceans	Exploratory multidisciplinary oceanographic survey.	Beddard, 1886; See www.19thcenturyscience.org/HMSC/HMSC-INDEX/index-linked.htm for a link to all zoological reports from the voyage.
UK (Ireland)	*Lord Bandon*	1885, 1886, 1888	Irish waters	To investigate the fauna of the 100 fathom line off the south-west coast of Ireland, comprising dredge sampling.	Haddon, 1886; Haddon and Green, 1889; O'Riordan, 1967; Sladen, 1891; Went, 1967.

UK (Ireland)	*HMS Research*	1889	Irish waters	Faunal survey comprising trawl sampling.	Bourne, 1889.
UK (Ireland)	*Flying Fox*	1889-1890	Irish waters	Faunal survey comprising beam trawl and dredge sampling.	Green, 1889.
UK (Ireland)	*Fingal*	1890	Irish waters	Faunal survey comprising beam trawl sampling.	Holt, 1892; Went 1967.
UK (Ireland)	*Harlequin*	1891	Irish waters	Faunal survey comprising beam trawl sampling.	Holt, 1892; Went, 1967.
UK (Ireland)	*Granuaile*	1896	Irish waters	Faunal survey comprising Agassiz trawl sampling.	Green, 1896; Praeger, 1897.
UK (Ireland)	*Helga*	1901-1904	Deep water west of Ireland	Faunal survey comprising hauls.	Tattersall, 1905.
UK (Ireland)	*Helga II*	1904-1914	Irish waters	Faunal survey comprising hauls.	Clarke, 1913; Farran, 1913; Massy, 1920.
Denmark	Danish *Ingolf* Expedition	1895–1896	Faeroes, Iceland and South Greenland	Deep-sea investigation.	Hansen, 1908, 1913, 1916, 1920, 1923.
Denmark	Danish *Galathea* Round the World Expedition	1950–1952	World's oceans	Deep-sea round the world investigation.	Wolff, 1956, 1962.

France	Campagne Noratlane aboard *RV Jean Charcot*	1969	Deep North Atlantic	Faunal sampling.	Chardy, 1972, 1974a, b, c.
France	Campagne Walda aboard the *RV Jean Charcot*	1971	Deep North Atlantic	Faunal sampling.	Chardy, 1974a, 1974b
France	Campagne Biaçores aboard the *RV Jean Charcot*	1971	Azores region and La Chapelle bank	Oceanographic survey organized by MNHN.	Emig, 1972; Monniot and Monniot, 1973; Chardy, 1975; Young 1998.
UK (Scotland)	Rockall Time series by Scottish Association of Marine Science (SAMS)	1972-present	Rockall Trough	Time series study of bathyal and abyssal benthos sampling programme.	Harrison, 1987; Harrison, 1988; Lincoln, 1985; Greenwood *et al.,* 2001.
France	Campagne Biogas IV	1973	Gulf de Gascogne	Multidisciplinary survey.	Chardy, 1975; Laubier and Sibuet, 1977.
France/ Sweden	NORBI expedition	1975	Norwegian-Greenland Seas	Deep-sea exploration.	Svavarsson, 1982, 1984, 1988a, 1988b; Svavarsson *et al.*, 1993.

USA	WHOI transects	1976	Rockall Trough, Porcupine Seabight	Benthic sampling *via* transects.	Kavanagh, F. A. *et al.*, 2006.
UK (England)	IOSDL Porcupine Seabight	1977-1986	Porcupine Seabight	Survey of mega-, macro- and meiofauna.	See http://eprints.soton.ac.uk/. for most publications and reports.
US	FRAM I Drift-Ice expedition	1979	Polar Sea	Oceanographic study.	Hunkins *et al*., 1979; Just, 1980.
Sweden	*Ymer*-80 Expedition	1980	North Polar Sea	Multi-disciplinary expedition.	Svavarsson, 1984; 1988a; 1988b.
Norway	University of Bergen survey: *RV Håkon Mosby*	1981	Norwegian Sea	Deep-sea exploration.	Svavarsson, 1984, 1988a, b.
Denmark	BIOFAR	1990	Slope south of Faeroes	Faunal survey.	Johansen and Brattegard, 1998; Klitgaard, 1991 (reports).
European Union (MAST I Framework)	'Natural variability and the prediction of change in marine benthic ecosystems'	1990-1993	North East Atlantic slope and abyssal plains	Describing environmental and biological variability at different temporal and spatial time scales; investigating effects of disturbance on benthos.	Publications can be searched at http://www.cordis.lu/guidance/services.htm

European Union (MAST II Framework)	'Community structure and processes in the deep-sea benthos'	1993-1996	Porcupine, Madeira, Cape Verde abyssal plains	Comparison of benthic communities disturbed by phytodetritus with undisturbed communities.	As above, publications can be searched at http://www.cordis.lu/guidance/services.htm
European Union (MAST II Framework)	OMEX 1	1992-1996	Transects of continental margin in Goban Spur (Porcupine Seabight) area	Physical, chemical and biological processes at ocean margins controlling transport of material from shelf into deep-sea	Duineveld, G. C. A. *et al.*, 1997. See also http://www.cordis.lu/guidance/services.htm
European Union (MAST III Framework)		1994-1998	Atlantic Ocean	To understand how marine systems function at basin scales, in order to prepare for sustainable use of the oceans and determine their role in global change.	See the following website for a list of publications from MAST III http://www.cordis.lu/mast/src/pubs.htm
UK	AFEN (Atlantic margin environmental surveys of the seafloor)	1996 and 1998	UK Atlantic margin oil province	Environmental management of oil-producing areas.	Final report is available as a cd-rom from the publisher geotek at www.geotek.co.uk

UK	Strategic Environmental Assessment (SEA) by UK Department of Trade and Industry (DTI).	1999-Present (SEA1 - SEA7)	UK Contintental Shelf	Environmental assessment of the UK Contintental shelf .	CD-ROMs available from http://www.offshore-sea.org.uk/site/scripts/products.php
Ireland	Environmental Impact Assessment Aqua-Fact	2003	West of Mayo, Ireland	Environmental assessment of potential oil field.	Environmental assessment report.
Ireland	NUIG PRTLI (Cycle 3)	2003-present	West of Ireland-Porcupine Bank and Seabight	Multidisciplinary project incorporating geophysics, oceanography, microbiology and benthic zoology	Barry and McCormack, 2007; Kavanagh *et. al*., 2006; Koennecker, 2005; McCarthy *et. al*., 2006. See also www.nuigalway.ie

TABLE 2. Depth range of Asellota (Isopoda) recorded form the North East Atlantic study area.

Species	Depth range (m)	Species	Depth range (m)
Dendrotion elegans	1600–2200	*Bathybadistes spinosissima*	2900
Dendrotion paradoxum	441–1504	*Echinozone coronata*	188–808
Dendrotion setosum	362–1160	*Disconectes furcatus*	390-979
Dendrotion spinosum	282–408	*Diconectes latirostris*	246-633
Dendromunna compsa	2900	*Disconectes phallangium*	536-633
Eugerda tenuimana	62–1484	*Eurycope ?cornuta*	789
Eugerdella hessleri	814–3620	*Eurycope producta*	441–978.7
Desmosoma lineare	699–1564	*Ilyarachna antarctica*	3859
Oecidiobranchus nanseni	844–2300	*Ilyarachna longicornis*	364–4632
Antennuloniscus simplex	1900	*Ilyarachna polita*	3859
Antennuloniscus diversus	1800–2755	*?Ilyarachna triangulata*	2868–4632
Chauliodoniscus armadilloides	2200–476	*Munnopsis beddardi*	364–699
Haploniscus aduncus	2636–2646	*Munnopsis typica*	979
Haploniscus ampliatus	2636–2925	*Munnopsurus longipes*	640–1564
Haploniscus angustus	1231–2900	*Munneurycope murrayi*	640–1280
Haploniscus bicuspis	428–1321	*Paramunnopsis oceanica*	1370–2100
Haploniscus borealis	441–1632	*Tytthocope megalura*	364–1624
Haploniscus foresti	1632–3697	*Lipomera (Lipomera) lamellata*	364
Haploniscus hamatus	2878–2925	*Gracilimesus celticensis*	1491–1500
Haploniscus ingolfi	2465–3283	*Gracilimesus ?gorbunovi*	441–1582

TABLE 2 (Continued).

Species	Depth range (m)	Species	Depth range (m)
Gracilimesus modestus	2765	*Pleurogonium inerme*	364–1094
Heteromesus greeni	364–2200	*Pleurogonium pulchrum*	1208
Heteromesus longiremis	1018–4100	*Pleurogonium rubicundum*	20–789
Heteromesus spinosus	1022–2770	*Munna fabricii*	0–366
Ischnomesus armatus	2770	*Munna kroyeri*	0–408
Ischnomesus bispinosus	344–1163	*Munna limicola*	536
Janira maculosa	201–967	*Nannoniscus oblongus*	495–979
Ianiropsis breviremis	128	*Pseudomesus brevicornis*	2200–2770
Janirella priseri	2900	*Thambema amicorum*	1330–2900
Macrostylis magnifica	2900	*Thambema golanachum*	1800
Macrostylis spinifera	542–1208	*Thambema fiatum*	1800
Macrostylis subinermis	2800	*Thambema tanum*	2875
Metamunna typica	219–300	*Tole laciniata*	448-979
Paramunna bilobata	148–219		

TABLE 3. Number of genera and species of Asellota (Isopoda) recorded per family in the North East Atlantic study area.

Family	No. of genera	No. of described species	No. of undescribed species	No. of species
Dendrotioniidae	2	5	1	6
Desmosomatidae	3	5	0	5
Haploniscidae	3	11	0	11
Munnopsididae	8	18	7	25
Ischnomesidae	3	8	0	8
Janiridae	2	2	0	2
Janirellidae	1	1	2	3
Macrostylidae	1	3	1	4
Paramunnidae	3	5	2	7
Munnidae	1	5	0	5
Nannoniscidae	1	1	0	1
Pseudomesidae	1	1	0	1
Thambematidae	2	4	0	4
Incertae Sedis	1	1	0	1

TABLE 4. Summary of samples of Asellota (Isopoda) collected by NUIG 2003-2004 in the North East Atlantic study area.

(Sub)Family	No. samples	No. specimens	%	No. genera	No. species
Haploniscidae	6	85	17.4	2	5
Ischnomesidae	8	76	15.6	3	5
Paramunnidae	2	71	14.6	1	3
Eurycopidae	6	70	14.4	2	11
Ilyarachnidae	6	59	12.1	1	1
Dendrotioniidae	2	38	7.8	1	3
Janirellidae	4	33	6.8	1	2
Nannoniscidae	5	20	4.1	1	1
Janiridae	6	11	2.3	1	1
Macrostylidae	4	7	1.4	1	4
Desmosomatidae	1	6	1.2	1	1
Munnopsidae	2	6	1.2	1	1
Pseudomesidae	3	4	0.8	1	1

NOTABLE CADDISFLIES (TRICHOPTERA) FROM SCRAGH BOG, CO. WESTMEATH, INCLUDING *EROTESIS BALTICA* MCLACHLAN NEW TO IRELAND

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Scragh Bog, Co. Westmeath (N4259), is a small (*circa* 16ha) and largely undisturbed valley fen located in central Ireland at an altitude of *circa* 100m. The site is extremely wet with a number of distinct habitats ranging from areas of open water to fen woodland. Like most Irish place names, Scragh Bog, derived from the Irish 'scraith' meaning scraw or mat and 'bog' indicating soft, captures an essential feature of the site namely its quaking scraw surface. This is formed from the matted rhizomes and roots of wetland plants. A consistently high water table level is also a feature of the site. In summer, the water table seldom drops to more than a few centimeters below the moss lawns and, in winter, water is visible in most small hollows and depressions. For brief periods during severe winter rains, flooding may take place so that open sheets of water interrupted only by the tops of tussocky vegetation and by willow *Salix* and birch *Betula* trees can be seen. The minerotrophic fen has been defined as a "rheotrophic swingmire". It is of international importance and contains rare plants, mosses and insects (Anon., 2009; O'Connell, 1987; Speight and Legrand, 1984). However, until the present study by the senior author, nothing was known about the trichopteran fauna. A total of three notable species have been discovered in collections made at the site including *Erotesis baltica* McLachlan new to Ireland and these records are given below. The larvae were determined by EH using Wallace *et al.* (2003) and the identity of those of *E. baltica* confirmed by JPOC. The adults were identified by JPOC using Macan (1973) and Malicky (2004). Voucher specimens

have been deposited in the National Museum of Ireland.

***Erotesis baltica* McLachlan, 1877 (Leptoceridae)** **New to Ireland**

Larvae were collected in August 2006 but these were early instars and the distinctive subocular ecdysial line with its dorsal branch was not evident on the specimens. Subsequently, numerous instar V larvae were taken in April 2007 and the line was obvious on these individuals. The larvae occurred amongst a range of vegetation characteristic of a calcareous fen including *Carex lasiocarpa* (slender sedge), *Menyanthes trifoliata* (bog bean) and *Schoenus nigricans* (black bean rush). Adults (5♂♂1♀) were swept from the vegetation on 25 August 2008.

E. baltica is a very interesting addition to the Irish fauna. It is important that the species has been discovered in a designated National Nature Reserve as the caddisfly may be under threat elsewhere in the British Isles. The species was first found in Great Britain at Wicken Fen (McLachlan, 1877). Subsequently, it was discovered to be numerous there and at Chippenham Fen (King, 1892). Its present status in Britain is RDB 2 (Vulnerable), a status which is assigned to taxa that may move into the Endangered category in the near future. The species still inhabits Wicken Fen, Cambridgeshire and also Catfield Fen, Norfolk. It also occurs in the English Lake District and on the Isle of Anglesey but it has not yet been refound at some previous 19th century sites. Larvae occur among submerged parts of fairly dense emergent vegetation in dykes and lake margins. The Wicken Fen site is very small while the Catfield Fen site cannot be considered safe due to the potential threat of scrubbing (Wallace, 1990; Wallace *et al*., 2003). Surprisingly, the species was not taken in the extensive Rothamsted Insect Survey (Crichton *et al.*, 1978). Elsewhere, *E. baltica* has been reported from Austria, Czech Republic, Denmark, Finland, Germany, Hungary, Italy, Latvia, Lithuania, Norway, Poland, Russia, Slovakia, Sweden, Switzerland and The Netherlands and it is also under threat in many of these countries (Nógrádi and Uherkovich, 1999; Stloukal, 2001; Aagaard *et al*., 2006; Malicky, 2007).

***Limnephilus ignavus* McLachlan, 1865 (Limnephilidae)**

The larvae of *Limnephilus ignavus* were collected on 30 May 2006 and this is the first record of the larvae from Ireland. An adult (♂) was swept from the fen on 25 August 2008. King and Halbert (1910) recorded the adults from Cos Mayo, Waterford, Westmeath and Wexford. Subsequently, adults have been taken in Cos Cavan, Kildare and Wicklow. These records are as follows:- CAVAN: Lough Sillan (H6907), ♀ 11 August 1972, swept from lakeside vegetation, JPOC; KILDARE: Louisa Bridge near Leixlip (N9936), ♂♀ 2 August 1982, swept from vegetation in the marsh, JPOC; WICKLOW: Kilmacanoge marsh (O2514), ♂ swept from alders *Alnus* and weeds along the stream, JPOC; near the Sugar Loaf (O2312), ♀ 15 August 1982, swept from marshy ground, JPOC.

In Great Britain, where it inhabits ditches and flowing marshes with much emergent vegetation, *L. ignavus* has been classified as local and regionally notable. Although the adult has a summer diapause, the waterbodies may not completely dry up during summer (Wallace, 1990).

***Phacopteryx brevipennis* Curtis, 1834 (Limnephilidae)**

Larvae of *Phacopteryx brevipennis* were found in both May 2006 and April 2007. An adult (♂) was swept from the fen on 25 August 2008. This species is only known from two other Irish sites. It was added to the Irish list by Wallace *et al.* (1983) from an alder marsh near Virginia, Co. Cavan. In 1987, it was discovered in a small pool near Ballynafid Lake, Co. Westmeath (O'Connor and O'Hanrahan, 1988).

In Great Britain, *P. brevipennis* is classed as a notable species. It inhabits pools with a slight water flow in dense reed-fen or carr woodland and these pools dry up in the summer. The adult is very secretive and difficult to catch with a net (Wallace, 1990). Indeed, in the earlier Irish records, adults were bred from collected larvae.

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COLEOPTERA FROM MONTANE BLANKET BOG IN THE WICKLOW MOUNTAINS, IRELAND

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Summary

This paper describes the beetle fauna from a pitfall trap survey of one area of the Wicklow uplands carried out in 1998 and reported by Nolan (2002). A range of uncommonly recorded species and some rarities are noted. Results are compared with studies of the beetle fauna from lowland blanket bog and collections from other high altitude locations in Ireland.

Introduction

Nolan (2002) undertook a survey of spiders over an extended period (May to October, 1998) during which forty-five spider species were recorded including several restricted to montane habitats in Ireland and one new Irish record. The aim of the present paper is to describe the beetle fauna collected in that study and to put the results in the context of similar studies from Irish uplands and blanket bog. The dataset of beetle occurrence was quite uneven due to variation in trapping regimen between sampling stations, flooding, loss or destruction of traps, etc. Thus, it was not possible to extract seasonal patterns of species abundance. Information on vegetation and substrate characteristics were also limited, however, some general observations can be made.

Comparison of the spider fauna of Three Lakes with that of lowland bogs and fens showed

that there was some overlap in species composition (Nolan, 2002). Comparison with similar studies from uplands in Britain showed that the recorded fauna was clearly impoverished. Nolan's (2002) study also highlighted the scarcity of information on invertebrates in uplands in Ireland. A brief overview of the work on the beetles and spiders at high altitude in Ireland is given in McCormack *et al.* (2006). That paper also reported on a survey of fifteen sites spread across three mountain areas in northern and western Ireland. Beetles and spiders were sampled with pitfall traps for varying periods between April and June. Habitats sampled ranged from 350m to 780m and included montane blanket bog as well as more exposed heaths and scree near summits. A total of 93 beetle species were recorded including several with very restricted distributions in Ireland. The spider fauna was also found to have a number of rare species restricted to high altitudes in the British Isles and one species was a new Irish record (Nolan and McCormack, 2004).

Irish mountains certainly hold many as yet unrecorded invertebrate species. Some are presumably relicts from early post-glacial times while others are more likely to be recent arrivals e.g. *Bombus monticola* Smith (Hymenoptera: Aculeata). The scarcity of records from uplands however, certainly leaves room for the possibility that species have simply been overlooked. Anderson (2000) compared the carabid beetle faunas of Britain and Ireland based on species geographic ranges. Species classified as Arctic-montane, Boreo-arctic, Wide boreal and Boreal-montane are relatively well represented (≥60%) in Ireland despite the lack of very high mountains and the oceanicity of the climate.

Ecological studies on invertebrates in blanket bog habitats in Ireland have concentrated on ground beetle and spider communities from low altitude sites. Several studies have shown that ground beetle communities of blanket bogs are impacted by vegetation management which alters vegetation composition and structure and hence the suitability of the habitat for shade-requiring species (McDonnell *et al.*, 2002; McFerran *et al.*, 1994; Woodcock *et al.*, 2004). Dwarf shrubs are an important element of upland habitats for many species of invertebrates, providing shade and structure. Cameron *et al.* (2000) classified carabid beetle assemblages in Northern Ireland including many from dwarf shrub heaths, some of which, i.e. various *Carabus*

species, *Abax parallelepipedus* (Piller and Mitterpacher), *Cychrus caraboides* (L.) and *Calathus micropterus* (Duftschmid) are typically associated with woodland, dwarf shrub heath comprising a secondary habitat.

Hammond (1979) estimated the area of blanket bog in Wicklow to be over 15,000ha. The habitat is a mosaic of acid pools, permanently waterlogged mosses, and graminoid-dominated or dwarf shrub-dominated patches grading into heaths, upland grasslands, and rocky habitats. On better drained areas grassland and dry heaths occur. Vegetation communities of blanket bog and wet heath are dominated by *Eriophorum vaginatum* L., *Trichophorum cespitosum* (L.) Hartman, *Calluna vulgaris* (L.) Hull, *Erica tetralix* L. and *Vaccinium myrtillus* L. (Fossitt, 2000). Upland habitats are subject to frequent rainfall and cloud cover, low temperatures and high exposure to wind. The habitat is also characterized by low nutrient and mineral availability, low pH and a homogeneous substrate.

Materials and methods

The study site is in the mountains at the western end of the Glenmalure valley in the Wicklow Mountains. A site description, materials and methods, sampling dates, and weather data are detailed in Nolan (2002). Eight sampling stations were selected and between two and four traps were set at each (Table 1). Stations were set in a more or less linear array over a distance of approximately 600m at an altitude of 630m starting from T034983 and tending west-north-west. Stations d, g and h were the wettest. Dates of sampling are also given in Table 2. Nomenclature follows Duff (2008).

TABLE 1. Habitat descriptions, sampling stations and number of pifall traps per station.

Station	Habitat description	Traps
a	elevated position on an overgrown granite prominence	4
b	broad and flat, *Calluna* and *Trichophorum* dominant, deep peat	4
c	slightly sheltered, rather shallow peat	4
d	close to running water, partly inundated, moss and tall *Juncus*	4
e	*Calluna*, *Trichophorum* dominated, broad deep hag	4
f	shallow peat, slightly stony substrate, driest station	4
g	permanent standing water, slightly elevated, mosses	3
h	permanent standing water, slightly sheltered, mosses	2
i	broad hag, deep peat, *Calluna* and *Trichophorum*, western aspect	3

Results

A total of 1,568 beetles were identified representing 82 species from 13 families (Table 2). Thirteen beetle families were represented. Of these, 20 species were carabids and 39 were staphylinids which are usually the dominant beetle families in pitfall trap surveys. The other 23 species belonged to 11 beetle families and these were (with no. of spp. in brackets): Anthicidae (1), Curculionidae (1), Dytiscidae (3), Elateridae (4), Hydrophilidae (4), Lathridiidae (2), Leiodidae (2), Monotomidae (1), Nitidulidae (3), Scarabaeidae (1) and Scydmaenidae (1).

Trechus obtusus was the most abundant species with 271 individuals trapped. *Quedius molochinus* and *Abax parallelepipedus* were the next most abundant with 199 and 98 individuals trapped, respectively. These three species represented 36% of the entire catch. *T. obtusus* and *A. parallelepipedus* were the only species trapped at all locations. These three species are very widespread and common in a variety of habitats across Ireland at high and low altitude.

The most species-rich site was station f with 44 species in total and this was also the driest

site. Station d was the least species rich with 17 species. This site near to running water and was flooded for part of the trapping period. Mean species richness per site was 30.3.

Notable species

CARABIDAE

Miscodera arctica was added to the Irish list by Alexander (1993) from the summit of Slieve Donard. It is a local species in the British Isles being known from two sites in Northern Ireland and from mountains across Britain. It ranges across northern Europe, Siberia and North America. One was recorded at station f.

STAPHYLINIDAE

Atheta hypnorum is known in Ireland from Muckross, Co. Kerry (Janson, 1920) and Cloghoge, Co. Wicklow in 1991 (Good, 1999). In this study four specimens were recorded, one each from stations e, f, g and h.

Lesteva monticola is a local species recorded from high mountains but it is apparently very widespread with records from Cos Kerry, Sligo, Mayo and Wicklow (McCormack *et al*., 2006; Anderson, 1997). One specimen was trapped at station f.

Liogluta alpestris is a rare species in Ireland and this appears to be the first record since those of Champion for Slieve Donard, Co. Down in 1875 and Buckle (1900) who recorded it from the Foyle district. Seven specimens were recorded from stations b and d.

Mycetoporus rufescens is associated with moss in woods and upland heaths. Irish records are few with the first by Johnson from Armagh in 1891 (Johnson and Halbert, 1902). There are three unpublished records however, for pitfalls on montane peat at Slieveanorra, Co. Antrim in 1991 (pers. comm. of D. McFerran) and one for a pitfall in orchards at Loughgall, Co. Armagh in June 2001. Three specimens were trapped, two from station f and one from station i.

Oxypoda induta is known from just one other site in Ireland, in flood refuse on the River Flesk at Killarney, Co. Kerry (near Bullock's house) (Bullock, 1928). Twenty specimens were identified from station e, a hag with *Calluna* and *Trichophorum*.

Parabolitobius inclinans is apparently local in Ireland and although it is not regarded as an upland species, three of the five known Irish sites are over 600m (Anderson, 1997; McCormack *et al*., 2006). It was trapped at stations e and f.

Tachinus elongatus was noted by Anderson (1997) as an uncommon beetle in Ireland with few widely scattered records. There is one recent record from 600m on the Mweelrea Mountains, Co. Mayo (McCormack *et al*., 2006). Previously recorded from Co. Wicklow at Djouce Mountain in 1897 by Bullock and from lowland sites in Cos Dublin, Donegal and Fermanagh (Johnson and Halbert, 1902; Anderson, 1997). It was trapped at station e.

In addition to the above there are species which consistently turn up in montane habitats but which are not restricted to higher altitudes. Among the staphylinids are *Mniusa incrassata, Othius subuliformis* and *Quedius boopoides. Mniusa* often turns up in *Rhacomitrium* heath on scree at higher altitudes in Ireland but also occurs consistently under bark of fallen trees in old woodland, a very strange dichotomy in habitat preference. *O. subuliformis* (= *myrmecophilus* Kiesenwetter) is more tied to montane sites, often in *Rhacomitrium* heath but also moss under *Calluna. Q. boopoides* has about nine authenticated Irish records, with a 50:50 split between lowland transition mires and montane heath or summits.

Then there are the larger carabids which in Europe would be classified as forest dwellers but in Britain and Ireland more frequently occur in dwarf shrub heath, which appears to act as a substitute woodland habitat. Examples are the snail-eating *Cychrus caraboides* which would be restricted to a slug diet on hills, *Carabus problematicus* and *C. nemoralis.* Non-woodland species often occurring with these on mountains include the upland form of *Calathus melanocephalus* (var. *nubigena* Haliday), *Nebria rufescens, Notiophilus germinyi, Patrobus assimilis* and *Pterostichus adstrictus. Pterostichus rhaeticus* was recorded here to the exclusion of its very closely similar sibling species *Pterostichus nigrita* which replaces it in richer habitats at low altitude.

Lastly, there is a category which defies rationalisation, though lowland insects often appear capriciously on mountains, probably caught on updrafts or colliding with summits as part of the aerial plankton. Two such are *Epuraea rufomarginata* and *Glischrochilus hortensis,* both

uncommon saproxylic species of old woodland. It seems unlikely they permanently occupy sites in the study area.

Discussion

The Three Lakes site supports an interesting beetle assemblage with some very uncommon species and is the first study of the beetle fauna of the Wicklow uplands. At a national scale there is a paucity of information on the Irish upland invertebrate fauna and considering that a large proportion of our national parks are uplands and/or blanket bog, this study goes a little way to addressing the large gap in our knowledge of these habitats. Combined with the work by McCormack *et al.* (2006) and Nolan (2002), we have an insight into the Irish upland terrestrial beetle and spider faunas. This fauna consists of both specialist (cold-adapted) montane species and eurytopic species. Of the 20 carabid species found at Three Lakes, three were boreo-arctic species, two were boreal-montane, nine boreo-temperate, four wide-temperate and two were temperate as classified by Anderson (2000) (Table 3). When compared with the Irish fauna, there was a high representation of Ireland's cold-adapted boreo-arctic montane species (60%) and a low representation of temperate species (Table 3). There were fewer montane species found during this study than in McCormack *et al.* (2006) and Johnson and Halbert (1912) who looked at upland invertebrates from Cos Donegal, Sligo, and Mayo (300 to 780m) and from Croagh Patrick in Co. Mayo (765m), respectively (Table 3). This is most probably due to the homogeneity of the Wicklow site as only habitats on peat were examined. McCormack *et al.* (2006) and Johnson and Halbert (1912) surveyed mainly summits and exposed sites as well as upland blanket bog. The Wicklow fauna was more similar to that found by McDonnell *et al.* (2002) and Woodcock *et al.* (2004) (Table 3) whose work focused on blanket bogs at lower altitudes (170-300m and 130-300m, respectively). The number of species across the studies is also fairly similar with Woodcock *et al.* (2004) recording 25 species and McDonnell *et al.* (2002) 18 species. Surveys of mountain summits in the east and south of Ireland could be interesting since there are very few records of beetles from these areas. The climate may be less oceanic than that in the west and northwest and this may influence the invertebrate species

assemblages.

At Three Lakes a few species showed clear associations with wetter or drier sampling stations. Of 97 individuals of *Pterostichus adstrictus* trapped, only four were from the wettest stations (d, g and h) whilst it was most abundant at station f, the driest site. Anderson *et al.* (2000) note that this species is associated with wet heath but the data here suggest that it avoids the wettest parts. This agrees with Gardner *et al.* (1997) who found that *P. adstrictus* was associated with drier, open sites of heather moorlands in Scotland. Three species were observed to be more abundant at the three wettest stations. Two of these, *Loricera pilicornis* and *Lesteva sicula* occur at high and low altitude with *L. sicula* common in wetlands generally. The third species, *Liogluta alpestris* is very uncommon in Ireland. It was most abundant at station d which may indicate a preference for wet sites. Three spider species recorded by Nolan (2002) showed a strong association with the wetter parts of montane blanket bog surveyed.

The most species-rich stations, e and f, were also the driest. Of the eight noteworthy species mentioned above, five were found at station f and three were exclusive to that station: *Oxypoda induta, Lesteva monticola* and *Miscodera arctica*. Station e, which had a single extended trapping period from 17/18 May to 8 October, had four of the noteworthy species of which one was unique to that site. Eyre *et al.* (2003) studying management of grouse moor in Scotland also found that dry, open *Calluna* dominated sites were more species rich and supported more rare carabid species than wetter *Molinia* dominated sites. Wetter sites did support a small number of rare species although streamside sediments were found to have the largest assemblages of rare and scarce species. Speight (2004) identified the potential importance of supplementary features of blanket bogs such as streams, pools, springs and flushes for increasing the diversity of invertebrates in an otherwise relatively homogeneous habitat. The presence of grazers on blanket bog also provides habitat for species dependant on dung such as many of the staphylinids, dung beetles and sphaeridiine hydrophilids as well as many other invertebrates. Cameron *et al.* (2000) and Gardner *et al.* (1997) found the main factors affecting carabid communities of dwarf shrub heath and blanket bog to be drainage and openness, the latter character heavily influenced by grazing and management practices. Both of these studies

focused on the ground beetle communities, however Eyre *et al.* (2003) found that spiders and rove beetles, unlike ground beetles, did not respond positively to management by burning or grazing, with no rare staphylinids or spiders associated with dry open *Calluna* sites.

Conclusions

The beetle fauna recorded from Three Lakes was similar to that of lowland blanket bog with the exception of a small number of species restricted to high altitudes, a situation essentially similar to that of the spiders. Combined with previous work it is clear that there is a suite of rare invertebrate species on Irish mountains. The more specialist montane species are found predominantly in open, exposed habitats and drier areas of upland blanket bog with relatively few montane species associated with wetter areas. These areas however were found to support some notable invertebrates and a number of hygrophilous species. There are also a number of species characteristic of blanket bog that depend on shelter and shade provided by dwarf shrubs. It appears that a mosaic of wet/dry, sheltered/exposed areas is necessary to maintain the diversity of invertebrates in upland blanket bog habitat. Overgrown blanket bog and heath is likely to become less diverse through loss of species preferring open habitats, the resulting fauna tending to resemble an impoverished woodland fauna. Maintenance of the balance between open and sheltered conditions requires appropriate management by grazing and burning. The presence of grazers also provides habitat for dung feeding invertebrates. It is hoped that this paper will encourage further work on Irish upland invertebrates that will address the large gaps in our knowledge and better inform conservation management.

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TABLE 2. Beetles from pitfall traps at Three Lakes, Co. Wicklow between May – October 1998.

Sampling station	a				b					c				d				e	f				g				h				i		
Trap period	17/18 May-5 Jun	5 Jun-26 Jun	26 Jun-27 Aug	27 Aug-18 Sep	17 May-5 Jun	5 Jun-26 Jun	26 Jun-27 Aug	27 Aug-18 Sep	18 Sep-8 Oct	17/18 May-5 Jun	5 Jun-26 Jun	26 Jun-27 Aug	27 Aug-18 Sep	17/18 May-5 Jun	5 June-26 Jun	26 June-27 Aug	27 Aug-18 Sept	18 May-8 Oct	18 May-5 June	5 June-14 Aug	14 Aug-18 Sept	18 Sep-8 Oct	18 May-5 Jun	5 Jun-14 Aug	14 Aug-18 Sep	18 Sep-8 Oct	18 May-5 Jun	5 Jun-14 Aug	14 Aug-18 Sep	18 Sep-8 Oct	5 Jun-14 Aug	14 Aug-18 Sep	18 Sep-8 Oct
Carabidae																																	
Abax parallelepipedus (Piller & Mitterpacher)	6	.	9	.	1	.	4	.	1	2	4	6	.	.	.	1	1	13	5	19	5	.	.	3	4	.	6	3	.	.	.	5	.
Agonum fuliginosum (Panzer)	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Calathus melanocephalus (L.)	1	.	4	.	.	.	5	1	.	.	.	.	.	.	.	.	.	47	.	10	2	1	.	.	.	.	.	.	.	.	6	.	.
Carabus granulatus L.	.	1	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carabus problematicus L.	.	.	4	.	.	.	1	1	.	.	.	6	1	.	.	.	.	1	1	1	.	.	.	.	1	.	1	.	.	1	1	3	1
Cychrus caraboides (L.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Leistus terminatus (Hellwig)	.	.	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	14	.	.	4	2	.	5	6	3	.	.	.	.	.	6	.
Loricera pilicornis (Fabricius)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Miscodera arctica (Paykull)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Nebria rufescens (Ström)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Nebria salina Fairmaire & Laboulbène	.	.	.	3	.	.	.	1	.	.	.	.	.	.	.	1	.	1	.	3	18	13	.	.	1	.	.	.	.	.	.	6	1
Notiophilus germinyi Fauvel	2	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	2	2	1	1	1	.	.	.	.	.	.	.	.	.	.	.
Olisthopus rotundatus (Paykull)	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Patrobus assimilis Chaudoir	.	.	2	.	.	.	9	.	1	.	.	5	.	.	.	.	.	16	.	7	.	1	2	4	.	.	.	9	.	.	4	2	1
Pterostichus adstrictus Eschscholtz	4	.	1	.	6	.	3	1	1	10	3	1	.	.	1	1	.	10	28	19	1	3	1	1	.	.	.	.	.	.	.	2	.
Pterostichus diligens (Sturm)	1	.	.	.	.	.	1	.	.	5	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
Pterostichus melanarius (Illiger)	2	.	.	.	.	.	3	.	.	6	5	3	.	.	.	1	.	1	5	21	10	.	.	1	1	.	.	.	.	.	4	6	.
Pterostichus niger (Schaller)	.	1	.	.	.	.	.	1	.	3	2	.	.	.	.	3	1	.	.	.	.	1	.	.	.	.	.	1	.	.	.	1	.

Sampling station	a				b				c				d				e	f				g				h				i		
Trap period	17/18 May-5 Jun	5 Jun-26 Jun	26 Jun-27 Aug	27 Aug-18 Sep	17 May-5 Jun	5 Jun-26 Jun	26 Jun-27 Aug	27 Aug-18 Sep	18 Sep-8 Oct	17/18 May-5 Jun	5 Jun-26 Jun	26 Jun-27 Aug	27 Aug-18 Sep	17/18 May-5 Jun	5 June-26 Jun	26 June-27 Aug	27 Aug-18 Sept	18 May-8 Oct	18 May-5 June	5 June-14 Aug	14 Aug-18 Sept	18 Sep-8 Oct	18 May-5 Jun	5 Jun-14 Aug	14 Aug-18 Sep	18 Sep-8 Oct	18 May-5 Jun	5 Jun-14 Aug	14 Aug-18 Sep	18 Sep-8 Oct	5 Jun-14 Aug	14 Aug-18 Sep	18 Sep-8 Oct
Pterostichus rhaeticus Heer	5	.	.	.	15	.	4	.	1	12	7	8	.	.	.	1	.	7	.	.	.	.	11	3	1	.	6	.	.	.	1	2	1
Trechus obtusus Erichson	6	.	7	.	1	.	9	.	2	20	6	2	3	.	.	.	1	58	12	33	13	3	3	31	5	1	1	3	3	.	22	21	5
Staphylinidae																																	
Aleochara bipustulata L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Amischa decipiens (Sharp)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Anotylus rugosus (Fabricius)	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Anthobium unicolor (Marsham)	.	.	.	.	.	.	.	.	.	1	2	.	3	.	.	.	2	.	1	.	1	.	.	.	1	2	.	.	12	4	.	12	4
Atheta hypnorum (Kiesenwetter)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	1	.	.	.	1	.	.	.	.	.
Atheta triangulum (Kraatz)	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Autalia rivularis (Gravenhorst)	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bisnius fimetarius (Gravenhorst)	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lathrobium brunnipes (Fabricius)	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Lathrobium fulvipenne (Gravenhorst)	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lesteva monticola Kiesenwetter	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Lesteva sicula Erichson	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	2	.	.	6	2	.	.	1
Liogluta alpestris (Heer)	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Liogluta longiuscula (Gravenhorst)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Microdota amicula (Stephens)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.
Mniusa incrassata (Mulsant & Rey)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Mocyta amplicollis (Mulsant & Rey)	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	10	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.

Sampling station	a				b				c				d				e	f			g				h				i		
Trap period	17/18 May-5 Jun	5 Jun-26 Jun	26 Jun-27 Aug	27 Aug-18 Sep	17 May-5 Jun	5 Jun-26 Jun	26 Jun-27 Aug	27 Aug-18 Sep	18 Sep-8 Oct	17/18 May-5 Jun	5 Jun-26 Jun	26 Jun-27 Aug	27 Aug-18 Sep	17/18 May-5 Jun	5 June-26 Jun	26 June-27 Aug	27 Aug-18 Sept	18 May-8 Oct	18 May-5 June	5 June-14 Aug	14 Aug-18 Sept	18 Sep-8 Oct	18 May-5 Jun	5 Jun-14 Aug	14 Aug-18 Sep	18 Sep-8 Oct	18 May-5 Jun	5 Jun-14 Aug	14 Aug-18 Sep	18 Sep-8 Oct	5 Jun-14 Aug	14 Aug-18 Sep	18 Sep-8 Oct
Mocyta fungi (Gravenhorst)	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Mycetoporus rufescens (Stephens)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.
Myllaena brevicornis (Matthews)	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Myllaena infuscata Kraatz	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ocalea picata (Stephens)	.	.	1	1	.	.	.	1	.	.	.	.	4	.	.	.	5	.	.	5	7	6	.	1	.	.	.	.	5	5	1	8	.
Olophrum piceum (Gyllenhal)	.	.	.	2	.	.	.	.	5	.	.	.	3	.	.	.	1	.	.	.	1	2	.	.	1	5	.	.	1	.	.	3	.
Omalium excavatum Stephens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Othius punctulatus (Goeze)	.	.	.	.	1	.	1	1	.	.	1	.	.	.	.	.	3	4	1	.	.	.	.	.	.	.	.	.	.	.	1	2	.
Othius subuliformis Stephens	.	.	.	.	2	.	.	.	.	1	2	.	.	.	.	.	9	1	3	2	.	.	.	.	.	.	.	2	.	.	.	1	.
Oxypoda brevicornis (Stephens)	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	11	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oxypoda induta (Mulsant & Rey)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Parabolitobius inclinans (Gravenhorst)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Philonthus longicornis Stephens	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Philonthus marginatus (Müller)	.	.	.	1	.	.	.	.	.	3	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Philonthus varians (Paykull)	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Quedius boopoides Munster	2	.	1	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.
Quedius molochinus (Gravenhorst)	.	.	.	.	.	.	3	.	.	.	1	1	4	.	.	.	1	84	.	40	24	1	1	8	2	1	.	4	.	.	15	9	.
Quedius umbrinus Erichson	3	.	.	.	1	.	.	.	1	1	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	1	.	.
Stenus impressus Germar	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Tachinus elongatus Gyllenhal	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tachinus laticollis Gravenhorst	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.

Sampling station	a				b				c				d				e	f			g				h				i		
Trap period	17/18 May-5 Jun	5 Jun-26 Jun	26 Jun-27 Aug	27 Aug-18 Sep	17 May-5 Jun	5 Jun-26 Jun	26 Jun-27 Aug	27 Aug-18 Sep	18 Sep-8 Oct	17/18 May-5 Jun	5 Jun-26 Jun	26 Jun-27 Aug	27 Aug-18 Sep	17/18 May-5 Jun	5 June-26 Jun	26 June-27 Aug	27 Aug-18 Sept	18 May-8 Oct	18 May-5 June	5 June-14 Aug	14 Aug-18 Sept	18 Sep-8 Oct	18 May-5 Jun	5 Jun-14 Aug	14 Aug-18 Sep	18 Sep-8 Oct	18 May-5 Jun	5 Jun-14 Aug	14 Aug-18 Sep	18 Sep-8 Oct	5 Jun-14 Aug	14 Aug-18 Sep	18 Sep-8 Oct
Tachinus rufipes (L.)	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	3	.	2	.	.	1	.	.	.	.	.	.	.	.	.	.
Dytiscidae																																	
Hydroporus melanarius Sturm	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Hydroporus nigrita (Fabricius)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Hydroporus tristis (Paykull)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.
Leiodidae																																	
Catops fuscus (Panzer)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Choleva agilis (Illiger)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scydmaenidae																																	
Neuraphes elongatulus (Müller & Kunze)	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scarabaeidae																																	
Aphodius depressus (Kugelann)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hydrophilidae																																	
Anacaena globulus (Paykull)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	3	.	.	.	3	.	.	.	.	.
Cercyon analis (Paykull)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Cercyon impressus (Sturm)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Megasternum concinnum (Marsham)	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Elateridae																																	
Aplotarsus incanus (Gyllenhal)	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Sampling station	a				b					c				d				e	f				g				h				i		
Trap period	17/18 May-5 Jun	5 Jun-26 Jun	26 Jun-27 Aug	27 Aug-18 Sep	17 May-5 Jun	5 Jun-26 Jun	26 Jun-27 Aug	27 Aug-18 Sep	18 Sep-8 Oct	17/18 May-5 Jun	5 Jun-26 Jun	26 Jun-27 Aug	27 Aug-18 Sep	17/18 May-5 Jun	5 June-26 Jun	26 June-27 Aug	27 Aug-18 Sept	18 May-8 Oct	18 May-5 June	5 June-14 Aug	14 Aug-18 Sept	18 Sep-8 Oct	18 May-5 Jun	5 Jun-14 Aug	14 Aug-18 Sep	18 Sep-8 Oct	18 May-5 Jun	5 Jun-14 Aug	14 Aug-18 Sep	18 Sep-8 Oct	5 Jun-14 Aug	14 Aug-18 Sep	18 Sep-8 Oct
Ctenicera cuprea (Fabricius)	.	.	.	.	.	.	2	.	.	.	1	1	.	.	.	.	.	2	.	2	.	.	.	.	.	.	.	.	.	.	1	.	.
Dalopius marginatus (L.)	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hypnoidus riparius (Fabricius)	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	5	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Nitidulidae																																	
Epurea aestiva (L.)	.	.	.	.	1	.	.	.	.	.	.	.	2	.	.	.	.	1	.	.	.	.	1	1	.	.	.	.	.	.	1	.	.
Epurea rufomarginata (Stephens)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Glischrochilus hortensis (Geoffroy)	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	1	4	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Monotomidae																																	
Rhyzophagus dispar (Paykull)	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	3	.	.	1	2	.	.	.	1	.	2	1	.
Lathridiidae																																	
Cartodere nodifer (Westwood)	1	.	.	.	2	.	.	.	.	6	1	.	.	.	.	.	.	3	15	2	1	.	.	1	.	.	1	.	.	.	.	.	.
Corticaria elongata (Gyllenhal)	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anthicidae																																	
Omonadus floralis (L.)	.	.	.	.	1	.	.	.	.	2	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Curculionidae																																	
Hylastes sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Number of beetles	**33**	**3**	**34**	**7**	**33**	**0**	**56**	**7**	**19**	**85**	**41**	**39**	**20**	**0**	**1**	**20**	**20**	**321**	**129**	**177**	**94**	**38**	**24**	**68**	**25**	**17**	**17**	**31**	**29**	**12**	**61**	**93**	**14**
Number of species	**11**	**3**	**13**	**4**	**12**	**0**	**20**	**7**	**10**	**23**	**18**	**14**	**7**	**0**	**1**	**10**	**10**	**39**	**22**	**24**	**16**	**14**	**10**	**18**	**11**	**9**	**7**	**12**	**7**	**4**	**14**	**19**	**7**

TABLE 3. Comparison of biogeographic biomes of carabid beetle assemblages from blanket bog and mountains in Ireland. Percentages are of the number of Irish species in these categories (as defined by Anderson (2000)).

Major biome	No. of Irish carabids	No. of carabids: (this study)	Woodcock *et al*. (2004)	McDonnell *et al*. (2002)	McCormack *et al*. (2006)	Johnson and Halbert (1912)
Altitude		630m	130-300m	170-300m	300-780m	765m
1 Arctic-montane	3	0 (0%)	0 (0%)	0 (0%)	2 (60%)	0 (0%)
2 Boreo-arctic montane	5	3 (60%)	0 (0%)	2 (40%)	2 (40%)	2 (40%)
3 Wide-boreal	9	0 (0%)	1 (11.1%)	0 (0%)	1 (11.1%)	1 (11.1%)
4 Boreal-montane	8	2 (25%)	0 (0%)	1 (12.5%)	4 (50%)	3 (37.5%)
5 Boreo-temperate	46	9 (19.5%)	9 (19.5%)	9 (19.5%)	12 (26%)	6 (13%)
6 Wide-temperate	74	4 (5.4%)	11 (14.8%)	5 (6.75%)	7 (9.4%)	5 (6.75%)
7 Temperate	31	2 (6.4%)	4 (12.9%)	1 (3.2%)	3 (9.6%)	1 (3.2%)
8 Southern-temperate	28	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
9 Mediterranean-Atlantic	8	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

NEW RECORDS FOR IRISH FALSE-SCORPIONS (ARACHNIDA: PSEUDOSCORPIONES), ALSO INCORPORATING A COUNTY CHECKLIST

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Introduction

The Irish pseudoscorpion fauna has been reviewed by Legg and O'Connor (1997). Since then additional records have been gathered by Cawley (2002) and Alexander (2004, 2005). The purpose of this article is to detail additional records, mostly gathered since 2002. The opportunity is also taken to provide an updated summary of county and offshore island records. No new Irish records for *Kewochthonius halberti* (Kew), *Chthonius orthodactylus* (Leach), *Roncocregas cambridgei* (L. Koch), *Lamprochernes savignyi* (Simon), *Pselaphochernes dubius* (O. P.-Cambridge), *Allochernes powelli* (Kew) or *Chelifer cancroides* (L.) have come to light over recent years. For the remaining species, updated distribution maps are also provided.

In the following article new county records are denoted using an asterisk (*). County records are summarised using the following abbreviations:- ANT = Antrim, ARM = Armagh, CAR = Carlow, CAV = Cavan, CLA = Clare, COR = Cork, DER = Derry, DON = Donegal, DOW = Down, DUB = Dublin, FER = Fermanagh, GAL = Galway, KER = Kerry, KLD = Kildare, KLK = Kilkenny, LAO = Laois, LEI = Leitrim, LIM = Limerick, LNF = Longford, LOU = Louth, MAY = Mayo, MEA = Meath, MON = Monaghan, OFF = Offaly, ROS = Roscommon, SLI = Sligo, TIP = Tipperary, TYR = Tyrone, WAT = Waterford, WES = Westmeath, WEX = Wexford and WIC = Wicklow. The present state of recording of pseudoscorpions in Ireland is summarised on Table 1. Species are also ranked on this table, taking into account the number of 10km square records, geographical spread and proportion of older records. Specimens were identified using Legg and Jones (1988).

FAMILY CHTHONIIDAE

***Kewochthonius halberti* (Kew)**

County checklist: DUB.

***Chthonius tetrachelatus* (Preyssler) (Figure 1)**

CORK: Ballintemple, Cork City W703709, 20 May 2009, leaf litter in a disused quarry. **DONEGAL**: Bundoran G802589, 24 April 2009, under stones on a coastal bank, with *Neobisium carcinoides* also present. **CLARE**: Ballyneillan R299797, 27 January 2008, ground layer moss in hazel *Corylus* woodland. **GALWAY**: *Ballynacragga, Inishmore L853107, 28 August 2007, in moss on a low limestone cliff, with *N. carcinoides* also present. **KERRY**: Camp Q699094, 9 October 2008, in moss on a tree trunk in woodland along the Finglas River; Knockglass Q710097, 18 October 2008, in moss on a wall at the edge of mooreland. **LOUTH**: Lordship J096091, 26 March 2008, in moss on a roadside bank. **LIMERICK**: Fairfield Glebe R624275, 14 December 2007, in moss on an old stone wall; Toryhill R531429, 25 July 2008, frequent in moss on exposed limestone, with *N. carcinoides* also present; Loghill R190499, 29 August 2008, under a stone on a patch of waste ground. **OFFALY**: *Clorhane M987277, 3 April 2008, sieved from ground layer moss collected in *Corylus* woodland. **TIPPERARY**: *Beakstown S0955, 15 April 2003, in moss on a well drained field bank.

Offshore island record: Cape Clear, Clare Island and Inishmore.

County checklist: ANT, CLA, COR, DER, DON, DOW, DUB, GAL, KER, KLK, LIM, LOU, MAY, OFF, ROS, SLI, TIP, WES and WIC.

***Chthonius ischnocheles* (Hermann) (Figure 2)**

CAVAN: *Headford Wood, Virginia N5987, 30 November 2006, leaf litter and ground layer moss in a mixed woodland with **N. carcinoides* also present. **CLARE**: Dromore Wood R3587, 10 October 2007, in moss on boulders in open deciduous woodland; Drumcliff Bridge R327791, 30 April 2008, frequent in leaf litter in disturbed mixed woodland, with *N. carcinoides* also present. **CORK**: Ballyfoyle W7653, 17 May 1998, under a stone at the ruins of a cottage; Ringaskiddy W7964, 23 June 2000, grassy sea cliff; Glenbower Wood W9977, 25 April 2003, at the base of vegetation in mixed woodland; Castlemartyr W9573, 17 March 2003,

in moss on a roadside bank; Skull V9230, 30 April 2006, under a stone at the edge of a field; Kinish Harbour, Sherkin Island W016252, 19 July 2006, coastal bank; Horseshoe Harbour, Sherkin Island W025251, 19 July 2006, rock face adjacent to heath; Carrigabrick W825991, 4 February 2007, in moss on exposed limestone in a mixed woodland, with *N. carcinoides* present in leaf litter; Bawnlahan W188345, 27 February 2008, in moss on rock face in deciduous woodland, with *N. carcinoides* present in leaf litter; Dunbulloge Bridge W687804, 6 April 2008, in ground layer moss in a patch of deciduous woodland, with *N. carcinoides* also present; Monition W432470, 4 July 2008, in leaf litter in mixed woodland. **DONEGAL**: Beefpark G8876, 2 November 2005, in moss in sand dunes. **DUBLIN**: Santry Demense O166405, 30 September 2008, leaf litter in deciduous woodland. **GALWAY**: Castlequarter M425022, 12 September 2006, in moss on limestone pavement; Coole Lough M434039, 13 May 2007, ground layer moss in mixed deciduous woodland. **KERRY**: Lough V454998, 28 August 2008, in moss on a coastal wall. **KILDARE**: Moore Abbey Wood N635089, 27 April 2007, present, with *N. carcinoides* in beech *Fagus* leaf litter; Landenstown Bridge N849248, 9 August 2008, leaf litter in a mixed woodland. **KILKENNY**: Thomastown S580411, 24 July 2008, in leaf litter in a narrow bank of mixed deciduous woodland, with *N. carcinoides* also present; Clonassy S551227, 3 August 2008, present with *N. carcinoides* under stones at the edge of a field. **LAOIS**: Dunmore Wood S4178, 18 April 2003, leaf litter in mixed woodland; Carrick Wood N5410, 16 December 2005, present, with *N. carcinoides*, in leaf litter in a mixed woodland; Old Kyle S233901, 26 March 2007, under a stone in a graveyard; Mondrehid S2690, 26 March 2007, hedgebank moss; Borris-in-Ossory S250875, 26 March 2007, in moss on an old stone wall; Ballyfin Church N392016, 21 April 2007, leaf litter in *Fagus* woodland; Grantstown Wood S3380, 29 May 2007, ground layer moss/leaf litter, in lakeshore woodland, with *N. carcinoides* also present. **LEITRIM**: Milltown Wood G874404, 16 April 2009, singleton among wood-rush *Luzula* in mixed woodland, with *N. carcinoides* present in numbers; Kilmore Wood G793346, 25 April 2009, leaf litter in a deciduous woodland. **LONGFORD**: Cloonkeen N177574, 18 March 2009, frequent in *Fagus* leaf litter; Bunanass N061845, 23 March 2009, sieved from *Fagus* leaf litter in a hedgerow. **LOUTH**: Lordship J101085, 26 March 2008, under

debris on a grassy coastal bank. **LIMERICK**: Garrynoe R602288, 28 May 2007, in moss on an old limestone wall; Killacolla R133478, 29 August 2008, in moss on a roadside bank; Loghill R191501, 29 August 2008, under stones just above estuarine high-water-mark. **MEATH**: Hamwood N987409, 20 October 2008, leaf litter in planted woodland. **OFFALY**: *Dungar S1491, 1 February 2007, frequent in moss on a bank under mature *Fagus*. **TYRONE**: Knockroe H563493, 15 January 2009, singleton in leaf litter in mixed deciduous woodland, with *N. carcinoides* present in numbers; Mullaghtinny H550520, 15 January 2009, in moss on riverside bank. **WATERFORD**: Passage East S7009, 10 June 2001, coastal heath; Bawnacarrigaun X240904, 20 May 2003, present with *N. carcinoides* in coastal *Phragmites* marsh; Rincrew X094809, 16 February 2006, in moss on tree trunk in *Fagus* woodland, with *N. carcinoides* present in leaf litter. **WESTMEATH**: *Ballynafid N405614, 17 April 2009, frequent in leaf litter in planted woodland. **WEXFORD**: Ballyhack S7110, 6 June 2005, coastal heath; Macmurroughs S730298, 6 June 2008, frequent in leaf litter in planted woodland, with *N. carcinoides* also present.

Offshore island record: Cape Clear, Sherkin and Inishmore.

County checklist: Recorded from every Irish county.

***Chthonius orthodactylus* (Leach)**

County checklist: LAO.

FAMILY NEOBISIIDAE

***Neobisium maritimum* (Leach) (Figure 3)**

DONEGAL: *Bundoran G802589, 24 April 2009. **MAYO**: Capnagower, Clare Island L715865, 17 September 2002. In both cases, the species was present in inter-tidal rock fissures.

Offshore island record: Clare Island.

County checklist: COR, DON, DOW, DUB, KER, MAY, SLI and WEX.

***Neobisium carpenteri* (Kew) (Figure 4)**

CORK: Moyny Wood W1146, 27 October 2003, in moss on a tree trunk in a small patch of deciduous woodland; Coolacullig W4574, 19 January 2006, in moss on *Fagus* trunks at edge of a conifer plantation, and in moss on a nearby stone wall; Currahaly Cross Roads W495693, 19

February 2006, in moss on a tree trunk in hillside deciduous woodland, with *N. carcinoides* present in leaf litter; Drombrow W022501, 21 February 2006, in moss on *Fagus* trunks in planted woodland, with *N. carcinoides* present in leaf litter; Skull V935319, 30 April 2006, in dry moss on a roadside bank; Glengarriff V9156, 7 July 2006, beaten from vegetation in mixed woodland; Darkwood W2253, 9 October 2006, in moss on an old stone wall; Leap W201366, 26 September 2008, in moss on tree trunks and among *Luzula* on a bank in mixed woodland, with *C. ischnocheles* and *N. carcinoides* present in leaf litter; Douglas W699688, 6 January 2009. Present at this site, rather unusually, in leaf litter on a low hillside in mixed suburban woodland, in association with *Roncus lubricus*.

N. carpenteri has proved to be widespread in west and mid Cork, where it is an almost predictable woodland invertebrate. Reported from Co. Kerry by Alexander (2005). A generally arboreal species, most easily recorded by sieving moss collected from tree trunks and branches. Despite searches, the species remains unrecorded from east Cork and Waterford.

County checklist: COR and KER.

***Neobisium carcinoides* Hermann (Figure 5)**

CAVAN: Corratirrim H079356, 14 May 2008, in moss under *Corylus* on limestone cliff. **CLARE**: Brian Boru's Fort, Killaloe R696742, 8 November 2007, sieved from *Fagus* leaf litter collected in a dry moat surrounding ancient earthworks; Caherbannagh R286818, 27 January 2008, frequent in hedgerow moss. **CORK**: Ballincollig Regional Park W5770, 11 January 2003, *Fagus* leaf litter; Castlemartyr W9573, 1 February 2003, leaf litter in planted woodland; Halfway W5961, 4 February 2003, in moss on an old stone wall; Curragh Wood W8476, 27 February 2003, leaf litter in mixed woodland; Ward's Bridge W8189, 2 February 2006, frequent in leaf litter/moss in deciduous woodland; Maulanimirish W202492, 20 February 2007, ground layer moss in conifer plantation; Garravagh W5671, 22 February 2007, leaf litter in planted deciduous woodland; Roury Bridge W260366, 13 March 2008, in moss on tree trunks in mixed planted woodland; Monteen W438472, 4 July 2008, under a stone on a dry bank. **DERRY**: Ness Wood C527114, 10 January 2007, among *Luzula* clumps in oak *Quercus* woodland.

DONEGAL: Troopers Hill H1295, 1 November 2005, leaf litter in mixed woodland. **DUBLIN**: Lucan O038357, 5 October 2008, leaf litter in mixed woodland. **FERMANAGH**: Marlbank H092362, 28 April 2009, in moss on a roadside bank. **GALWAY**: Recess L8547, 2 December 2005, leaf litter in acid woodland; Garryland M419035, 26 June 2006, leaf litter in mixed woodland; Knockmaa M359484, 26 September 2007, in moss on limestone pavement, and present also in leaf litter in adjacent mixed woodland; Rossaveel Hill L958247, 19 February 2008, in leaf litter under willow *Salix* on coastal heath, and present also in moss on adjacent stone wall. **KERRY**: Torc V9684, 20 November 2002, mixed leaf litter; Gortnaglogh Q8903, 30 January 2007, in moss in a hedgerow; Barraduff W085905, 21 March 2007, ground layer moss in *Corylus* woodland. **KILDARE**: Maynooth N924374, 20 September 2008, sieved from leaf litter in a *Fagus* dominated hedgerow along the Royal Canal. **KILKENNY**: Knockdav S324654, 13 April 2008, in moss on hillside *Corylus* scrub. **LAOIS**: Abbeyleix Wood S4284, 16 March 2003, in *Quercus* leaf litter. **LEITRIM**: Glenfarne H0138, 26 November 2002, in moss on a stone wall. **LIMERICK**: Knockfeerina R4436, 11 September 2005, in moss on heath; Eyon R738508, 4 May 2006, *Salix* leaf litter in scrub woodland. **LOUTH**: Seapoint O1580, 15 June 2005, sand dunes; Lordship J096091, 26 March 2008, leaf litter in disturbed deciduous scrub. **MAYO**: Portlea, Clare Island L7086, 8 May 2002, leaf litter in deciduous woodland; Gortnafolla M212933, 19 January 2009, leaf litter in *Fagus* woodland. **MONAGHAN**: *Corlattan H6531, 22 August 2005, leaf litter in mixed planted woodland; Lough Naglack, H853027, 28 May 2009, leaf litter in a patch of planted woodland, with *C. ischnocheles* also present. **OFFALY**: Rathmoyle S022801, 5 April 2007, *Fagus* leaf litter in patch of deciduous woodland. **ROSCOMMON**: *Lough Key Forest Park G834040, 12 January 2009, leaf litter in mixed woodland. **SLIGO**: Carns G7034, 12 November 2002, deciduous leaf litter. This species was never before encountered at this site despite occasional sampling of leaf litter, which invariably turns up *C. ischnocheles*; Knocknarea G6234, 4 January 2006, in moss on heath at c300m; Union Wood G6728, 16 January 2008, in moss on tree trunks, and among *Luzula* in *Quercus* woodland. **TIPPERARY**: *Corville S154875, 1 February 2007, ground layer moss and leaf litter in conifer plantation; Monaincha Church S168884, 4 May 2007,

among *Carex* in a ditch. **TYRONE**: Annagh H446490, 4 January 2007, sieved from moss collected in a small area of blanket bog. **WATERFORD**: Skehacrine X278938, 14 January 2003, frequent in moss on a small patch of sand dune; Bawnatanavoher X2494, 21 February 2003, moss on a stone wall; Farbreaga S2803, 14 September 2003, in moss on mountain summit at c550m. **WEXFORD**: Carrowreagh Holy Well S8922, 3 December 2004, in moss under conifers; Castlebridge T0426, 21 June 2005, ground layer debris in a coastal *Phragmites* marsh. Offshore island record: Clare Island and Inishmore.

County checklist: Recorded from every Irish county except Longford and Meath.

***Roncus lubricus* L. Koch (Figure 6)**

CORK: Glenbower Wood W9977, 7 January 2003, sieved from deciduous leaf litter in mixed woodland, with *N. carcinoides* also present; Sally Port W657490, 31 January 2008, in leaf litter in a small coastal sycamore *Acer pseudoplatanus* L. copse; Courtmacsherry Wood W524428, 6 February 2008, frequent in leaf litter in deciduous woodland, with *N. carcinoides* also present; Ballincollig Castle W587697, 17 October 2008, present, with *C. ischnocheles* in mainly *Salix* leaf litter in a small shrubby area.

County checklist: ANT, COR, DOW, SLI, WAT and WEX.

***Roncocregas cambridgei* (L. Koch)**

County checklist: ANT, COR, DER and KER.

FAMILY CHEIRIDIIDAE

***Cheridium museorum* (Leach) (Figure 7)**

KERRY: *Milltown, Dingle Q433012, 24 September 2008, two adults and one nymph, with *C. ischnocheles* also present. **KILDARE**: *Maynooth N925374, 20 September 2008. A few specimens collected, with * *Dinocheirus panzeri* present in abundance.

In both instances specimens were sieved from debris collected in cowsheds. Although a small and very inconspicuous species, *C. museorum* seems to be genuinely scarce in Ireland. Certainly rather less in evidence than *D. panzeri* in cowsheds, at least in the south and the west, and possibly with an eastern bias.

County checklist: ANT, ARM, COR, DOW, DUB, KER, KLD and MON.

FAMILY CHERNETIDAE

***Lamprochernes savignyi* (Simon)**

County checklist: ANT and DUB.

***Lamprochernes nodosus* (Schrank) (Figure 8)**

TIPPERARY: Ferryhouse, Clonmel S237229, 7 June 2007, neglected patch of ground between the River Suir and St Joseph's Church. Still present in what is effectively a compost heap, from where it was reported by Cawley (2002). In the intervening years the nature of the compost heap has changed from predominantly leaves to grass cuttings, and other interesting invertebrates present in 2000 were absent in 2007.

County checklist: ANT, DOW and TIP.

***Pselaphochernes dubius* (O. P.- Cambridge)**

County checklist: ANT, DUB and WIC.

***Pselaphochernes scorpioides* (Hermann) (Figure 9)**

WEXFORD: *Kellys Wood, Camlin Hill S711255, 12 June 2008. Two adults and one nymph sieved from *Fagus*/holly *Ilex* leaf litter in mixed woodland, with *C. ischnocheles* and *N. carcinoides* both present in numbers.

Likely to be confined to the south, and an undoubted rarity in Ireland.

County checklist: COR, CAR and WEX.

***Allochernes powelli* (Kew)**

County checklist: SLI.

***Dinocheirus panzeri* (C. L. Koch) (Figure 10)**

DONEGAL: *Bundoran G833596, 24 April 2009. **FERMANAGH**: Mullaghbane H0937, 6 May 2004. **GALWAY**: *Furbo M197227, 2 April 2008. **LAOIS**: *Durrow S409774, 18 April 2003; Caher S259905, 26 March 2007; Borris-in-Ossory S247875, 26 March 2007. **KERRY**: *Ventry Q386002, 23 September 2008; Baile an Ghoilin V421991, 24 September 2008. **LIMERICK**: *Pallasbeg R745491, 4 May 2006; Glin R129476, 29 August 2008, with *C. ischnocheles* also present; Loghill R196504, 29 August 2008. **MONAGHAN**: *Magheraboy H838022, 28 May 2009. **OFFALY**: *Barnagrotty S018782, 2 April 2007, with *C. ischnocheles*

also present; Shannonbridge M967254, 3 April 2008. **TIPPERARY**: *Toomyvara R977778, 2 April 2007. **WATERFORD**: *Dungarvan X2794, 30 January 2003; Coolahest X101909 1 October 2003.

In all cases, specimens were sieved from debris collected in cowsheds or stables.

Offshore island record: Cape Clear.

County checklist: ANT, COR, DOW, FER, GAL, KER, KLD, KLK, LAO, LEI, LIM, LNF, MEA, MON, OFF, ROS, SLI, TIP, WAT and WEX.

FAMILY CHELIFERIDAE

***Chelifer cancroides* (L.)**

County checklist: ANT, DUB and LIM.

Discussion

Information on Ireland's pseudoscorpion fauna has increased significantly over recent years. This has largely been due to the activities of a very small number of workers, so much so that recorder bias could be having a very significant effect. For his part, the author generally collects pseudoscorpions by sieving leaf litter and moss, as well as debris collected in cowsheds. A handful of attempts at investigating birds' nests have proved fruitless, although these are known to have potential for some species. Likewise I have made few attempts to investigate dung heaps, and more especially compost heaps, and rarely search for *N. maritimum*. On the other hand a few attempts at investigating dry dead wood have drawn a blank. Some species, notably *N. maritimum* and *Lamprochernes* spp. could easily be grossly under-recorded. While bearing in mind these caveats, it is clear that *C. tetrachelatus*, *C. ischnocheles*, *N. carcinoides* and *D. panzeri* are all widespread in Ireland, with *P. scorpioides*, *P. dubius*, *A. powelli*, *C. cancroides* and especially *K. halberti* all remarkably scarce. It seems surprising that there are no recent records for *C. orthodactylus*, *A. powelli* and *R. cambridgei*, and the first of these is clearly in need of confirmation as an Irish species.

Acknowledgement

The distribution maps were generated using DMAP provided by Alan J. Morton.

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TABLE 1. Summary of Irish 10km square records for pseudoscorpions.

Species	Number of Irish 10km square records	Rank in Ireland
Kewochthonius halberti (Kew)	1	17
Chthonius tetrachelatus (Preyssler)	40	4
Chthonius ischnocheles (Hermann)	137	2
Chthonius orthodactylus (Leach)	1	16
Neobisium maritimum (Leach)	13	6
Neobisium carpenteri (Kew)	17	5
Neobisium carcinoides Hermann	142	1
Roncus lubricus L. Koch	13	7
Roncocregas cambridgei (L. Koch)	8	9
Cheridium museorum (Leach)	9	8
Lamprochernes savignyi (Simon)	3	13
Lamprochernes nodosus (Schrank)	3	11
Pselaphochernes scorpioides (Hermann)	3	10
Pselaphochernes dubius (O. P.-Cambridge)	3	12
Allochernes powelli (Kew)	1	15
Dinocheirus panzeri (C. L. Koch)	41	3
Chelifer cancroides (L.)	3	14
Total 10Km square records	438	

FIGURE 1. Distribution map for *Chthonius tetrachelatus* (Preyssler).

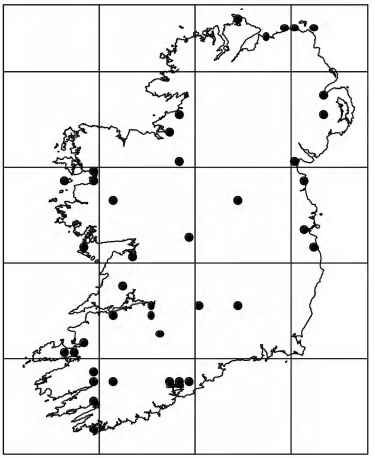


FIGURE 2. Distribution map for *Chthonius ischnocheles* (Hermann).

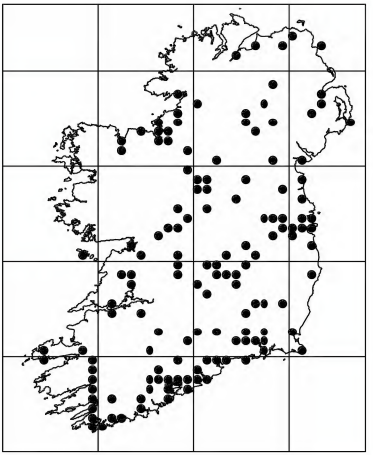


FIGURE 3. Distribution map for *Neobisium maritimum* Leach.

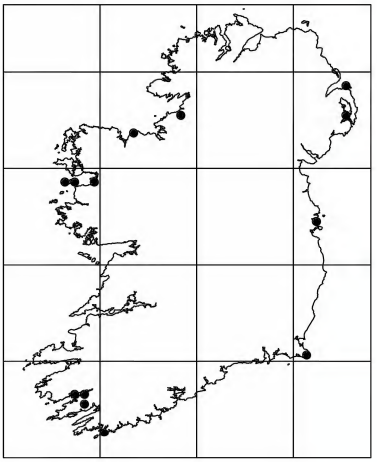


FIGURE 4. Distribution map for *Neobisium carpenteri* (Kew).

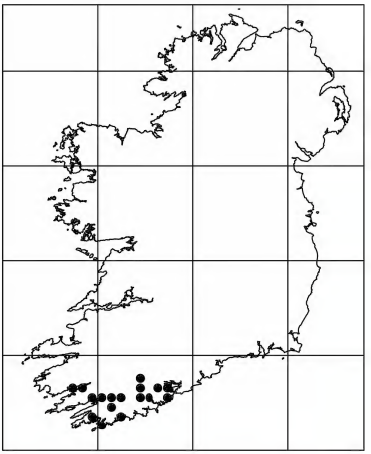


FIGURE 5. Distribution map for *Neobisium carcinoides* Hermann.

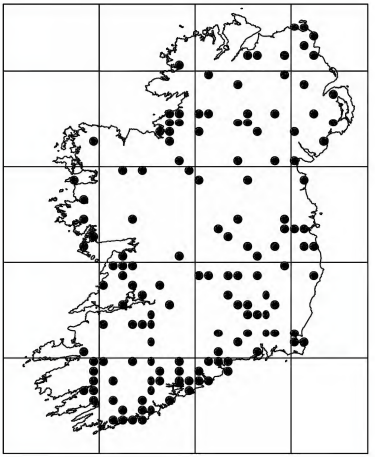


FIGURE 6. Distribution map for *Roncus lubricus* L. Koch.

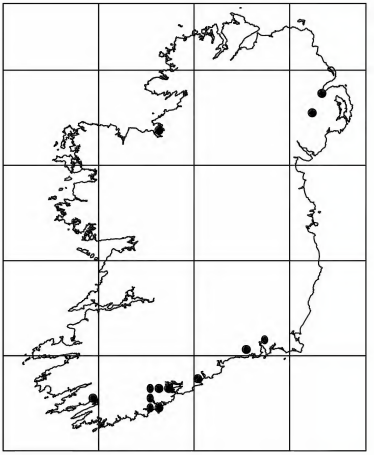


FIGURE 7. Distribution map for *Cheridium museorum* (Leach).

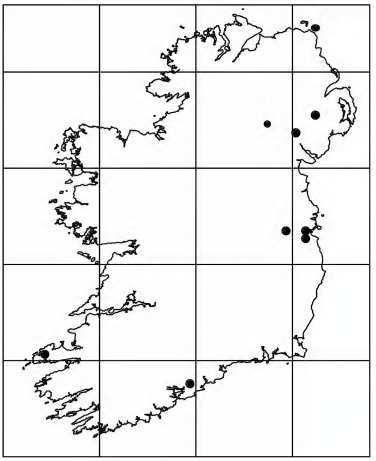


FIGURE 8. Distribution map for *Lamprochernes nodosus* (Schrank).

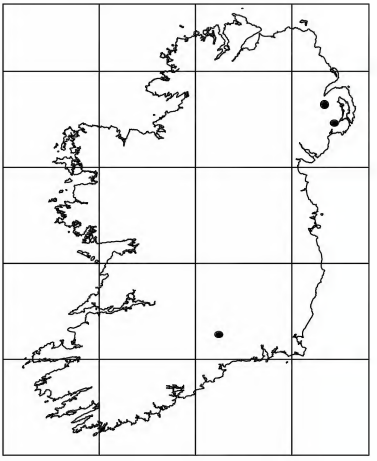


FIGURE 9. Distribution map for *Pselaphochernes scorpioides* (Hermann).

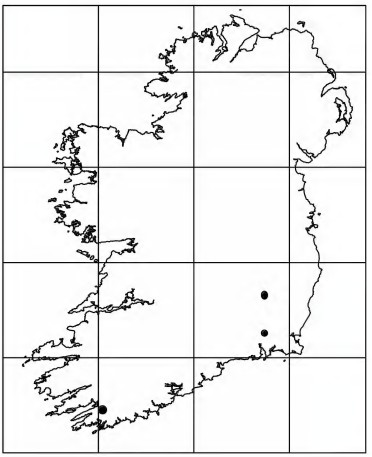
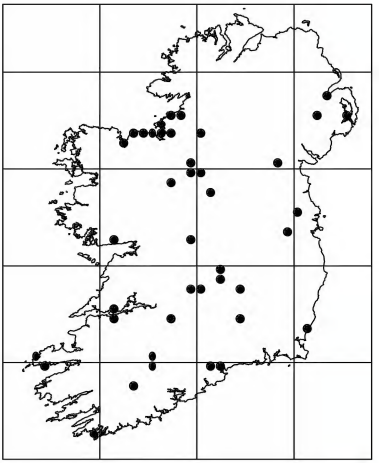


FIGURE 10. Distribution map for *Dinocheirus panzeri* (C. L. Koch).



LOCAL AND REGIONAL STUDIES OF CRYPTOBIOTA: ESOTERIC STAMP-COLLECTING OR ESSENTIAL ECOLOGY?

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Abstract

'Cryptobiota' are defined as species without a vernacular name. It is estimated that there are over 52,000 species of eukaryote cryptobiota in Ireland and its surrounding coastal seas. However, many people (including many scientists) may be unwilling to accept cryptobiota recording as a useful activity, if we cannot adequately and clearly explain its utilitarian value for the future. Most locally-distributed or rare species of tiny organism have little generally perceived value in themselves, but a convincing justification for cryptobiota inventory and recording is the long-term insurance or option value of semi-natural, self-sustaining, regionally-adapted ecosystems, rich in characteristic microenvironments and characteristic species. This biological insurance will become more valuable if current high productivity ecosystems become more expensive to support (over the next centuries and millennia), due to increasing input costs (e.g. phosphates), and due to costs associated with remediating the effects of low ecological resilience.

Introduction

There are probably over 20 million 'species' of small organism in Ireland and its surrounding coastal seas, of which over 52 thousand species are eukaryotes (i.e. not bacteria, etc. (prokaryotes))[1] This number of small eukaryote species is more than 16 times the

[1]See Tables 1 and 2; the concept of a prokaryote 'species' is different to that of a eukaryote (Konstantinidis *et al.*, 2006), and maybe of less relevance to biodiversity (Usher, 1997).

number of familiar large species of wildlife such as birds, flowering plants, mammals, fish, etc.[2] This small-sized and little-known wild life is the focus of many papers in this *Bulletin*, and for the purpose of this contribution they are collectively called 'cryptobiota', which can be defined as species without a vernacular name[3].

Despite this impressive diversity, public perception of the value of cryptobiota is poor. Many naturalists working on cryptobiota will be familiar with words like 'obscure' and 'esoteric' applied to these groups of organisms and to studies of their distribution or diversity. Many people do not understand why someone could spend their time studying 'creepy-crawlies' or 'tiny slimy things'. I am sure that I am not alone in having been asked the question: "What use are they?"

Scientific perception is also frequently dismissive. Professional ecologists, who use terms like 'keystone species', 'insignificant contribution' or 'functionally redundant' to emphasise the importance of dominant species over 'rare' ones in delivering 'ecosystem services', may often see cryptobiota recording as 'stamp-collecting'. Some people may even be reluctant to accept cryptobiota recording (including the maintenance of museum collections and record centre databases) as a legitimate activity if we cannot adequately explain its value in terms compatible with their perception.

Naturalists and cryptobiota ecologists rarely engage with such arguments, and are usually content to introduce their work as being a contribution to biodiversity without further explaining its value (e.g. see most contributions to Hawksworth and Bull, 2006). Yet taxonomists and naturalists could do more to communicate to a wider community the value of cryptobiota diversity (Speight, 1986; Kellert, 1993; Hall, 2008). This is especially so as cryptobiota taxonomy and scientific natural history are now in decline, both in Ireland and in their historical United Kingdom stronghold (O'Connor, 1997; Cheeseman and Key, 2007; Tiling, 2007; House of Lords Science and Technology Committee, 2008).

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[2]See Table 2. [3]See Note 1, before references.

Is cryptobiota recording, as some perceive, merely stamp-collecting: a Victorian cultural hangover irrelevant to contemporary economic or scientific life? Or is the exuberant diversity of these tiny but abundant organisms as ecologically important to biosphere management as that of birds and vascular plants? The purpose of this review is to examine adverse perceptions like those mentioned above, and to critically address the question of the value of local and regional recording of cryptobiota diversity.

Review method

It has been necessary to rootle through a wide range of literature on many subjects such as folklore, microbiology, theoretical ecology, history, resource economics etc., in an attempt to address the question of the perception and value of cryptobiota diversity. As I am not an expert in these fields, I have cited directly from the original texts rather than attempting to summarise them. As a consequence, this text in places approaches an annotated anthology. I have taken this approach so as not to lose the meaning clearly written in the original sources, and with, hopefully, insignificant contextual errors.

Also, the perspective that is taken here is one of anthropocentric utilitarianism. This is because it seems to be a dominant perception for many people who put social values well ahead of natural values. For this reason, arguments deriving from the intrinsic value of biodiversity, or from the moral religious obligation to preserve Creation, receive little or no discussion; the value in these cases is clear. It is not that these arguments are not considered valid, but that if we are to communicate value then we must do so in the context of the values of those with whom we are communicating. So, for this reason, particular attention is given to the likely basis for negative public and scientific perception of cryptobiota and their recording.

A further bias is that, like any cryptobiota specialist, I will refer most often to the group of organisms with which I am most familiar, namely arthropods, and in particular the hyper-diverse rove-beetles and their larvae (Coleoptera: Staphylinidae), currently with more than 630 recorded Irish species.

Adverse perception of cryptobiota and their recording

Negative public perception

As a result of increasing ecological awareness and education, many people appreciate the importance of ideas like ecological balance (Fischer and Young, 2007), and are likely to be more open to understanding the role of tiny organisms than in the past. Nevertheless, public perception of cryptobiota is for the most part indifferent (cryptogamic plants, microscopic organisms) or negative (mainly invertebrates) (e.g. Royal Horticultural Society, 2008; Speight, 1986; Kellert, 1993). For instance, a negative perception of insects is so generally entrenched that they are used as examples of unfavourable attitudes in the psychological Implicit Association Test (Oskamp and Schultz, 2005). For many people, there is likely to be an archetype of a scuttling scorpion-like or spider-like creature to be feared; perhaps a form of prepared learning translated into myth (Kellert, 1993; Wilson, 1998). This may be the basis for some of the incredible folklore associated with insects such as the *dara daol* or devil's coach-horse beetle (*Ocypus olens* (Müller)). In Ireland, and the Isle of Man, where it also was known as the *darbh daol* or *dearga daol*[4], and the tarroo-deyll, respectively (Dineen, 1927; Gill, 1932), it was despised as an evil insect and had a large folklore associated with it. This was summarised by Gill (1932) from an article in *Transactions of the Ossianic Society* (volume 5, 1857): "When the *dara dael* is seen in a house they always put a coal of fire on it (i.e. a piece of burning turf) and carefully sweep out the ashes afterwards, because fire is thought to exterminate evil spirits. It is never trodden under-foot or killed with a stick, for its demoniacal essence would penetrate the leather or wood and reach the foot or hand with grievous results; but may safely be killed with an iron spade. Among the many stories about the insect, the most remarkable is that of a young man who displayed superhuman strength and energy in threshing, and was afterwards found to have a *dara dael* hidden in the handle of his flail. He confessed that the Devil, with whom he had a compact, had told him to put it there."

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[4]See note 3, before references.

Such mythology may represent an innate negative reaction in many people to 'creepy-crawlies', mini-monstrous creatures which are 'alien' (Kellert, 1993; also in the title of the BBC series *Alien Empire* (O'Toole, 1995)). This is the opposite of a similar but positive human reaction to charismatic species like flowering plants, birds and mammals (termed biophilia by Wilson (1984)). We do not just respond to nature as it is, but bring our deep-seated cultural reactions to it (Schama, 1995). Thus, attempts to draw down to invertebrates the goodwill that many people have to 'animals' may run into difficulty, once we pass below recognisable charismatic types such as butterflies, dragonflies and ladybirds.

Perceptions of those who study cryptobiota can also be disparaging. Scientific sampling and specimen collecting represent to some people a prying, disintegrating attitude to the grandeur of nature, well described in some of the Romantic poetry of William Wordsworth reviewed by Wigglesworth (1976):

> "Physician, art thou? - one, all eyes
> Philosopher! a fingering slave
> One that would peep and botanise
> Upon his mother's grave?" - 'A Poet's Epitaph' (1799)

"Of mighty Nature ...

> Viewing all objects unremittingly
> In disconnection dead and spiritless;
> And still dividing, and dividing still,
> Break down all grandeur ..." - 'The Excursion' (1810-20)

Foster (1997), reviewing nineteenth century attitudes to nature in Ireland, gave further examples of the naturalist as socially inappropriate, even as a fool: "In Irish Romantic literature, during the early nineteenth century, there was little celebration of Irish nature for its own sake, as there was in English literature. The words 'nature', 'landscape' and 'scenery', in fact, have among the bulk of the Irish people to this day a somewhat effete connotation and evoke an Anglo-Irish world view. ... in J. M. Synge's famous play *The Playboy of the Western World* (1907), an inappropriate appreciation of nature ... is what marks Christy Mahon as a half-wit, according to his father."

Also in the nineteenth century, during the 1840s potato famine, there was scientific uncertainty as to the cause of late blight of potatoes, despite initial accurate diagnosis by several mycologists (Montagne, 1845; Morren, 1845; Berkeley, 1846). This uncertainty facilitated a providentialist belief as to the origin of the disease (the 'visitation of God'), even amongst influential scientists (Bourke, 1993; Semal, 1995). Such an explanation may have been more compatible with people's belief systems than was the concept of an obscure tiny organism (later discovered to be the fungus-like oomycete *Phytophora infestans* (Mont.) de Bary) as the cause: "More generally, the inability of the [Scientific] Commission and the leading European botanists to agree on a convincing diagnosis of the disease encouraged the tendency to look for supernatural causation. Even some of the minority who correctly identified the rot with the action of 'a minute parasitical fungus' attributed its appearance to divine direction." (Gray, 1999).

The point emerging is that people's perception may not be 'intuitively sympathetic' (Stewart and New, 2007) to the value or the importance of tiny, 'alien' organisms; they need to be convinced by clear demonstration of value to overcome an innate reaction. While it is unlikely that the historical attitudes described above have been carried forward into present-day perceptions of cryptobiota, the socio-cultural basis for these attitudes cannot be entirely dismissed.

Since the 1960s a new positive perception of nature has accompanied the rise in environmentalism, although this is perhaps more an urban rather than a rural phenomenon (Pender, 1998). To an extent, this new attitude can also become somewhat Romantic; for instance, the idea of killing invertebrates purely for their study would repulse some people (Corbet, 2007).

Deriving from this awareness, a number of writers have argued for the intrinsic value of species (see Primack, 1993; Samways, 2005); species have a right not to be made extinct. However, philosophers like John Passmore have been sceptical of the intrinsic rights of species (Passmore, 1980). According to Duddy (1997), Passmore's argument is that a new 'species rights' or 'nature rights' argument cannot be simply created: "A morality can only grow out of existing practices, values, and attitudes of mind, as an extension or development of them. People who are concerned about the environment are therefore better off working with and within the value-systems

that already exist in whatever cultural and ethical tradition they find themselves. For example, the idea of reverence for life which is promoted in the writing of some environmentalists is best understood as the development of an idea which is to be found in traditional religious and ethical thinking, namely, the idea of reverence for *human* life. It can be linked most specifically to the Jewish principle that it is wrong unnecessarily to destroy." (Duddy, 1997).

In contrast with such environmental ethics is the association of reliance on nature with poverty. There was (and in some countries still is), out of necessity, a greater use of natural ecosystems by poor communities (Dasgupta, 2005). But many people's perception, and particularly that of innovators and engineers, is that we have replaced our desperate historical reliance on natural systems with that of a constantly evolving technology where we can overcome future problems by substitution or innovation (e.g. Allwright, 2008). We will return to this point later, as it is critical to answering the question of utilitarian value of cryptobiota diversity.

Negative scientific perception

In order to demonstrate the importance of cryptobiota diversity, entomologists, mycologists and other specialists in cryptobiota groups often point to the sheer number of species in these groups. Measured as species richness, cryptobiota have considerably greater biodiversity than vertebrates or vascular plants. Data summarised in Tables 1 and 2 indicate that, for instance, the species diversity of Irish vascular plants is approximately only 10% of that of Irish arthropod cryptobiota.

However, practical conservation follows public perception, and does not value cryptobiota diversity relatively highly. This was well described by Ratcliffe (1977): "There is finally the awkward philosophical point that different kinds of organism do not rate equally in value because of bias in human interest, as regards numbers of people concerned. There is no disputing that, for instance, birds as a group attract a great deal more interest in the public generally than do spiders or beetles. Similarly, colourful wild flowers and rare orchids arouse more enthusiasm than toadstools or minute liverworts. While science may view all creatures as equal, therefore, pragmatism dictates that in nature conservation it is realistic to give more weight to some groups than others.""

A further example is provided by Pearlman and Adelson (1997): "The selection of which groups to include in an inventory depends greatly on the values and goals, as well as the budget and expertise, of the conservation decision makers asking for the survey. Foresters rarely call for inventories of salamanders, and few organisations have either the interest or the funds for extensive inventories of insects."

Public perception affects naturalists who work on cryptobiota. Amateur entomologists, for example, may be reluctant to promote their interest in insects, as pointed out by Speight (1986): "Among amateur entomologists in particular there is a tendency to use insects as an escape from the trials and tribulations of normal existence, to practice, as it were, zen through the art of entomology. Such a basis for involvement in the study of insects is not compatible with the demands of active involvement in promoting their conservation, since active involvement flings you directly into the hurly burly of human affairs once again. Then there are many entomologists who have been so conditioned by the attitude of the general population that they tend to hide their interest in insects from view, as though it were a perversion or vice that they are ashamed to admit to in public."

Professional taxonomists too complain of a negative perception from scientists, as mentioned in the report of a recent conference on taxonomy in Australia (Hall, 2008): "Others reported that among their scientist colleagues, taxonomists are commonly disregarded and dismissed. Their work is considered unimportant, boring, old-fashioned and pointless."

Such attitudes have a long history. One early twentieth century author, cited by Allen (1976), described the attitude of biologists as one of 'infinite contempt' for the naturalist: "W.B. Grove, an expert on microfungi, wrote in the *Midland Naturalist*: "The glory of the field naturalist has departed. The biologist or physiologist is the hero of the hour, and looks down with infinite contempt upon the luckless being who is still content to search for species...."

Indeed, the philosophical division between natural history and natural philosophy has, in the eyes of many academic scientists, relegated regional natural history to an art rather than a science:

"Ecology is a science intent on the development and assessment of objective scientific theory. Natural history is an art, the goal of which is the personal and subjective development of the individual practitioner (Hutchinson 1963)." (Peters, 1991; see original for cited reference).

Unfortunately, some scientists forget the importance of historical explanation to hypothesis development, and take an overly exclusive Popperian view of science as hypothesis-testing only. But it is also true that natural history itself is fragmented, and not inclined towards philosophical debate. Even amongst cryptobiota naturalists, there are social groups focussed on selected taxonomic groups (e.g. entomologists, mycologists, marine invertebrate zoologists, malacologists, bryologists) who often argue exclusively for their own conservation interests. As a consequence, for instance, the importance of protist diversity (see Corliss, 2002 and Cotterill *et al*., 2008), has virtually no conservation advocates in Ireland (but see Feehan and O'Donovan (1996) as an exception), and if raised as a conservation issue can be met by incomprehension or derision. In a Royal Irish Academy conference on biodiversity in 1995 (Rushton, 2000), only Murray (2000) briefly mentioned microbial diversity. It is not that microbial diversity is technically intractable (e.g. see Kreutz and Foissner (2006)); it just has not been considered as sufficiently worthwhile to overcome any technical difficulties that may exist.

With the exception of bryophytes and, to a lesser extent lichens (e.g. Rodwell, 1991-2000; Viney, 2003), many conservation and ecological texts ignore cryptobiota. For example, there is only one species of cryptobiota invertebrate (the crayfish *Cambarus carolinus* (Erichson)) mentioned in the 633-page text by DeGraaf and Miller (1996) entitled *Conservation of faunal diversity in forested landscapes*. An example of the *Ecosystems of the World* series, the 527-page volume 15 on forested wetlands (Lugo *et al*., 1990), mentions insect species only three times (biting swamp mosquitoes (twice) and six species amongst a list of 63 macrofauna from a Trinidad swamp).

Finally, for system ecologists advocating Gaia theory, it is the whole system rather than its component species that is important (Lovelock, 1988):

"Gaia theory forces a planetary perspective. It is the health of the planet that matters, not that of some individual species of organisms."

According to Marshall (2002): "Gaian ecology suggests, for example, that in the event of massive changes in the taxonomic composition of the Earth's biota, the identity of Gaia remains

unchanged because the mechanisms involved in the geophysiological processes of Gaia (i.e. matter and energy cycling) remain in place."

'Stamp collecting'

It is not surprising, then, that the taxonomic description, recording and inventory of flora and fauna are frequently perceived as 'stamp-collecting' by non-naturalist scientists. The term was originally, and famously, applied by the English physicist, Ernest Rutherford, to a large swathe of science: "All science is either physics or stamp collecting" (Birks, 1962). According to Kaku (a physicist) (1994): "By this, he [Rutherford] meant that science consists of two parts. The first is physics, which is based on the foundation of physical laws or principles. The second is taxonomy ("bug collecting" or stamp collecting), which is giving erudite Greek names for objects you know almost nothing about based on superficial similarities."

Another physicist, Luie Alverez, also applied the label, this time to palaeontology (Gould, 1989): "... Luie often lashed out at the entire profession [of palaeontology], and at historical science in general, claiming, for example, in an already infamous interview with the *New York Times*, "I don't like to say bad things about palaeontologists, but they're really not very good scientists. They're more like stamp collectors."

Franks *et al*. (1997), whose previous work had been criticized by Traniello and Rosengaus (1997) as not giving sufficient attention to uniqueness and history, again drew upon Rutherford's quip in response: "If we emphasize, to the exclusion of all else, the uniqueness of every social insect species, or indeed colony, in terms of its ecology and history, we would indeed be in danger of deserving Lord Rutherford's maxim: 'All science is either physics or stamp collecting'".

All three authors, however, mention the importance of explanation in contradistinction to stamp collecting; indeed 'stamp collecting' can also be applied to physics, and historical biology is not 'stamp-collecting' if it has explanatory power: "... the Standard Model is not real physics; it is more like stamp collecting arranging the subatomic particles according to some superficial symmetries, but without the vaguest hint of where the symmetries come from. Similarly, when Charles Darwin named his book *On the Origin of Species*, he was going far beyond taxonomy [i.e. 'stamp collecting'] by giving an *explanation* for the diversity of animals in nature. What is needed in physics is

a counterpart of this book, to be called *On the Origin of Symmetry*, which *explains* the reasons why certain symmetries are found in nature" (Kaku, 1994; italics added).

"I give Luie credit for saying out loud what many scientists of the stereotype think but dare not say, in the interests of harmony. The common epithet linking historical *explanation* with stamp collecting represents the classical arrogance of a field that does not understand the historian's attention to comparison among detailed particulars, all different." (Gould, 1989; italics added).

"Science seeks *explanation*: it is not merely a descriptive accounting procedure." (Franks *et al*., 1997; italics added).

Molecular geneticists too have been considered modern stamp-collectors, with DNA sequences replacing natural history specimens (Brooks, 2001), but it also has been accepted that the molecular 'stamps' must be collected first before we can begin to understand how to explain their existence: "Molecular-based research in microbial ecology has developed an image of "stamp-collecting", or the gathering of a lot of data because it is possible with the available tools. This enthusiasm for data collection is natural in an emerging field and was necessary when so little information was available before. Having any information is a giant leap forward, and no one knows *a priori* what will be the most interesting findings. Therefore, collecting microbiological stamps has been essential and will never disappear." (Rittmann *et al*., 2006).

Here we are beginning to see 'stamp collecting' as a sort of data resource, and being more maturely accepted as a necessary part of scientific development. According to Hayes (2004): "Computation has even rehabilitated some of Rutherford's stamp collecting disciplines. Those who compile lists and catalogs, who survey and classify, find their work newly glamorized in the age of data mining ... Astronomy has its own megacatalog: the Sloan Digital Sky Survey will list 100 million objects. What has made such undertakings newly fashionable is the possibility of doing more with the data once the gigabytes have been gathered up."

For biological recording, if we take 'stamp-collecting' to have the derogatory meaning as used by many scientists, then the key point is whether the data will have explanatory power at some stage taking into account, and as pointed out by Rittman *et al*. (2006), that we may not know *a priori* what will be the most useful sets of data. We know that reasonably detailed studies of cryptobiota diversity at a specific location can yield results useful to biodiversity

management. For instance, Økland (1994) provided data recommending avoidance of clear-cutting in forests with continuity of tree cover and substrates, in order to conserve mycetophilid fly diversity, and Speight and Good (2003) showed the greater role of old and senescent living trees (compared to dead wood) to syrphid fly assemblages, based on a data-base of syrphid ecological data (Speight *et al.*, 2002). But, even if cryptobiota data and surveys provide explanations of changes in ecosystem species-richness, this still does not answer the question 'what are the consequences of losing this species-richness if common species can perform the same ecological functions?' If cryptobiota diversity is not relevant to ecosystem functioning, then biological records will provide little of use as background data to explain ecosystem changes. The biodiversity-ecosystem functioning question must be answered first.

Value of species-rich ecosystems

Cryptobiota and ecosystem function

The argument is frequently made that we need to conserve cryptobiota species because of the role of those species in plant litter decomposition, pollination, seed dispersal, etc. However, it is important not to be disingenuous with this argument. If the 'ecological service' (e.g. litter decomposition) is mostly carried out by a few abundant species, but we then argue for the conservation of a set of rare species which have little significant quantitative role in that process, then we may be making a claim which does not stand up to scrutiny. Many species may be redundant (Waldbauer, 2003), so the argument of functional value requires critical evaluation (see review by Bolger, 2001).

There is no generally accepted ecological theory to explain why there are so many species, or whether this high level of species diversity is necessary for ecosystem function. For instance, it is not clearly known why there are so many species of insect (Lawton, 2001), and why so many of them are parasitoids (Godfray, 1994). Neither is the value of species diversity to ecosystem function and ecosystem services certain (Chapin *et al.*, 2000; Bengtsson *et al.*, 2002; Krautkramer, 2005; Srivastava and Vellend, 2005). Reviews of the literature on this subject have argued for diversity conservation because of this uncertainty: "We have no idea how

complex the many interspecific interactions in soil communities are or how much of the biodiversity is essential. Given this uncertainty, it would be wise to follow the advice of Costanza *et al.* (2000) and protect as many species as possible ..." (Bolger *et al.*, 2002).

"Sacrificing those aspects of ecosystems that are difficult or impossible to reconstruct, such as diversity, simply because we *are not yet certain* about the extent and mechanisms by which they affect ecosystem properties, will restrict future management options even further." (Hooper *et al.* 2005; italics added).

However, as in the nineteenth century example of potato blight mentioned above, arguments based on uncertainty are not well received by many people: "In the ecosystem functioning and biodiversity issue, at present our state of knowledge is well encompassed in the 'uncertainty principle' that is the basis of much of the discussions on biodiversity. The uncertainty principle is under attack, however, and politicians want more guidance than this statement of ignorance." (Mooney, 2002).

Indeed, authors such as Ehrenfeld (1988) questioned the valuation of species itself: "We do not know how many species are needed to keep the planet green and healthy, but it seems very unlikely to be anywhere near the more than quarter of a million we have now. ... And if we turn to invertebrates, the source of nearly all biological diversity, what biologist is willing to find a value - conventional or ecological - for all 600,000+ species of beetles?"

Marshall (2002) was also critical of ascribing value to the 'ecological job' that a species carries out: "It is always going to be impossible for human science to work out all the various jobs of every single one of the world's biotic members. So if we end up valuing species for nothing else but their jobs then we are likely to ignore and devalue all those invisible and unseen jobs which are performed in the ecological world in unnoticed ways or by unnoticed species."

A number of authors consider that the loss of 'keystone' species, or the loss of the last member species of a key functional group, will result in non-linear 'surprises' in ecosystem function (Chapin *et al.*, 2000). Many studies have shown the importance of adding functional groups (e.g. omnivorus nematodes, euedaphic Collembola) to ecosystem properties (e.g. N mineralisation, humification) (Curry, 1994), but as data on cryptobiota biology are often lacking then defining functional groups can often be arbitrary (Bolger, 2001).

However, the need to understand what exactly the role of species (as opposed to functional group) diversity is in ecosystem function has been a large new area of research over the last decade or so. Many of these studies are based on assumptions of comparatively uniform environmental conditions, and may not have sufficiently taken into account the existence of (1) the large diversity of microenvironments at intermediate level between individual species niches and ecosystems as a whole, (2) spatial heterogeneity of habitat patches, (3) the effects of nutrient availability, and (4) the degree to which a species is characteristic of, or adapted to, the local environment.

Microenvironments

As mentioned above, a number of theoretical models and experimental studies of the functional value of biodiversity have made simplified assumptions in relation to the uniformity of the environment in which they are undertaken when compared to real ecosystems. Some studies give a strong impression of a two-dimensional environment with gradual gradients in environmental conditions. In contrast, the field cryptobiota naturalist with experience in 'hunting' for species is highly aware of specific locations or combinations of circumstances which produce locally-distributed species which are nonetheless quite common within, and characteristic of, their favoured microenvironment.

Between the biodiversity categories of ecosystem and species, the concept of phytosociologically defined habitat types has predominated. These however, do not represent adequately the habitats of invertebrates (Speight *et al.*, 1997; Blake *et al.*, 2003) or other cryptobiota. Speight *et al.* (1997) listed site features for selected invertebrates which define their habitat. These features, referred to as 'microenvironments' here, are created by geophysical, geochemical or biological processes in ecosystems, often in mosaics (different parts of which can be used by a species at different stages in its life-cycle (e.g. Kirby, 1992)).

Examples of microenvironments which provide habitat for a cryptobiota group, staphylinid beetles, are given in Table 3. Some of these (geogenic microenvironments) are derived from geomorphological processes, others (biogenic microenvironments) from biological processes.

Some are decomposing organic accumulations, others are living plant and macrofungal microenvironments.

Fowles (1994) described the need to appreciate this microscale for invertebrates: "It is simply a question of scale and we must begin to recognise the intimate mixture of microhabitats within reserves and other valued sites, seeing more detail in the landscape than we did previously."

Apparently 'rare', stenotopic (habitat-specialised), species are often quite common within their preferred microenvironment, although this may occur in very small, locally-distributed patches within an ecosystem. Sample data for a number of stenotopic carabid and staphylinid beetles are given in Table 4, showing the relatively high percentage occurrence within their sampled assemblages. This is a point which can be lost when species number *versus* function graphs are presented. A typical graph shows a curve approaching an asymptote, with decreasing contribution to the measured ecosystem function (e.g. productivity, nitrogen-retention) as species are added. It appears that half of the species (at the furthest end of graph where the curve levels out) have little to contribute to the selected ecosystem function. But in their favoured microenvironment, which is probably underrepresented in the sample, these species can occur in the nearest part of the graph.

Also, species which are rare for many years, can suddenly increase in numbers to exploit a resource when it becomes available in large quantities. An example is the otherwise rare bark-beetle *Platypus cylindrus* (Fabricius), large populations of which developed on fallen oak, beech and sweet chestnut after the 1987 storm in south-east England (Winter, 1992). Lovejoy (1994) cited a further example of a rare mercury-reducing yeast which became abundant in contaminated soils. Finally, some species may be diffusively rare (Novotný and Basset, 2000), but they are contributing a small amount in each of a range of communities and their role can be underestimated if it is defined according to one vegetation-defined habitat type.

Microenvironments can also include drought stress-free or predator-free refuges (Mikola *et al.*, 2002), environments with a higher probability of chance conditions suitable for spore germination, better dispersal routes from a breeding habitat, etc.

Nevertheless, even where microenvironments are recognised, there will remain many species with a similar ecological role (i.e. redundant species).

Spatio-temporal variability

More species can co-exist if the environment is spatially heterogeneous, allowing species which are weaker competitors but better dispersers to colonise vacant microenvironments or patches of habitat (e.g. Hanksi and Ranta, 1983; Grover, 1997). Temporal variability in resources has also been found to facilitate microbial species diversity (Hiltunen *et al.*, 2008), and greater species coexistence due to environmental spatio-temporal variability has been established for terrestrial plant and soil communities (e.g. Questad and Foster, 2008; Giller, 1996). This spatio-temporal variability is often maintained by frequent natural disturbances, allowing weaker competitors to survive (Connell, 1978).

For cryptobiota, an example is provided by the 'paradox of the plankton' (Hutchinson, 1961). Ocean euphotic (exposed to light) surface water is a highly productive environment, but seemingly uniform and continuous. One would expect dominance (due to competitive exclusion) by a small number of species in such a uniform environment. However, the number of copepod species, for instance, can be surprisingly (paradoxically) high. An apparently uniform water mass in the North Pacific was found to contain 175 species of copepod by McGowan and Walker (1985). In a number of surveys, over one hundred years ago, on the Atlantic slope off Co. Mayo and Co. Galway, Farran (1905, 1908) recorded 130 marine pelagic euphotic-zone copepod species (Holmes, 2001; Holmes and Gotto, 1992, 2000; Holmes and O'Connor, 1990). According to Harris (1987), spatial and temporal heterogeneity are important factors in explaining this paradox: "Despite the uniform appearance of the pelagic environment, it is probable that it is physical structure and variability that provides the niche diversity required to explain the paradox of the plankton. … As the diel time scale is so important in planktonic communities, and cyclical behaviour affects the partitioning of both food and habitat resources, an important area of interaction is that between cyclical behaviour and spatial heterogeneity." (Harris, 1987).

Many apparently functionally 'extra' (redundant) species may survive in suitable microenvironmental patches of unpredictable occurrence in space and time, providing a functional presence where the other, often more abundant species is absent (see review by Bolger, 2001). On intertidal, reasonably sheltered, aerobic sandflats with a bubble-structure of air-pores (blasenwatt) in both Ireland and California there exist not one, but two, species of *Diglotta*, a tiny specialised marine staphylinid (rove-beetle). In California, *D. legneri* Moore and Legner rarely co-occurs with *D. pacifica* Fenyes (see Moore and Orth, 1979), and in north-west Europe *D. mersa* (Haliday) and *D. sinuaticollis* (Mulsant and Rey) appear to only co-occur at large sites (Good, 1998). In Great Britain and Ireland, *D. sinuaticollis* has potential conservation status because of its localised distribution. But that does not mean that it is functionally redundant and not abundant in some local patches of habitat where it occurs and where its congener *D. mersa* happens to be absent.

The existence of these extra species in large areas of biotope may also be partly due to the greater reliability of occurrence of vacant microhabitat patches. Landscape-scale is consequently critical to interpreting biodiversity-ecosystem function studies: "... studies of biodiversity and ecosystem functioning have been almost entirely performed within a fairly narrow scale paradigm emanating from classical (local) community ecology. If we want to answer questions about the consequences of biodiversity loss on larger scales than plots or microcosms, we need to incorporate insights from other perspectives emphasizing regional and landscape scales." (Bengtsson *et al.,* 2002).

Species-rich assemblages may thus have a role in dealing with spatially and temporally variable microenvironments where limiting resources are scattered. However, in human ecosystems, the environment is managed to reduce spatio-temporal variability (using external *energy* inputs), but also, critically, with external *nutrient* resource inputs. It could be argued that high species-richness is only necessary in low-productivity natural environments where resources are spatially and temporally scattered and not uniformly available. The question now emerges as to whether low productivity ecosystems are themselves redundant.

Nutrient availability

Discussing the results of biodiversity-productivity experiments, Huston and McBride (2002) drew attention to another paradox, the 'paradox of enrichment': "The conclusion of virtually all the 'biodiversity-productivity' experiments that productivity increases with increasing species diversity ... conflicts with the fact that most of the high productivity ecosystems around the world have strikingly low plant diversity. This phenomenon was well known to early ecologists (Lawes *et al*., 1882) and was succinctly summarized by Rosenzweig as the 'paradox of enrichment' (1971), referring to the diversity-reducing effects of added nutrients (i.e. eutrophication)." (Huston and McBride (2002); see original for cited references).

The functional roles of, at least, some cryptobiota groups are also greater in low-productivity ecosystems: "Several studies suggest that the importance of AMF [arbuscular mycorrhizal fungi] ceases when nutrient availability, in particular phosphorus supply, exceeds the level of demand (Koide 1991). ... These observations suggest that AMF are important for unproductive, nutrient-poor, species-rich grasslands, while they are expected to be relatively unimportant in productive, nutrient-rich, species-poor grasslands ..." (van der Heijden and Cornelissen, 2002).

The long-term sustainability of external nutrient inputs into ecosystems for production of useful products, and the resilience[5] of these enhanced ecosystems to environmental changes, would appear to be key questions in deciding whether human communities will need to rely on species-rich, low productivity ecosystems in the future.

Insurance (option) value of species-rich self-sustaining ecosystems

Many people will only be concerned by the loss of cryptobiota species if the species-rich ecosystems in which they occur are essential for future human resources. People pay insurance premiums on the basis of perceived risk: houses do burn down, cars are stolen and personal accidents do happen. Can we demonstrate risk by giving examples of resource degradation due to loss of characteristic cryptobiota species?

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[5]See Note 4, before references.

Other than with a few studies of pest and disease damage in crop and orchard ecosystems (e.g. Nitta (1991) cited by Chapin *et al.* (2000)), or studies of some pollinator communities (e.g. Klein *et al.*, 2003), it is difficult to find clear data to answer this question. The loss of a set of characteristic cryptobiota species is often accompanied by a decline in numbers of dominant species, and the effects are not clearly distinguishable. Human intervention in ecosystems has usually been too crude and state-changing to allow extrapolation solely to effects of the loss of biological diversity. There were, for instance, sets of saproxylic species lost from the Irish fauna due to deforestation, but the ecological effects are complicated by effects of prehistoric climate changes (Reilly, 2008).

However, there are studies which indicate that species-richness does indeed reduce ecosystem resilience and facilitates the retention of ecosystem resources: "... studies of both single trophic and multitrophic systems suggest that loss of diversity is likely to precipitate some reduction in ecosystem resistance or resilience. ... [M]aintaining diversity may be an important insurance strategy, ensuring the option of composition change in response to future stressors." (Srivastava and Vellend, 2005).

"Under regimes dominated by complex, species-diverse, self-managing, nutrient-conservative, natural grassland/prairie and forest ecosystems, erosion rates of soil mass are minimal, and the diverse and deep structure of the below-ground rooting community, and its microbial associates, makes the escape of plant nutrients entrained in downward-moving drainage (leaching) water to the ocean very difficult." (Salonius, 2008).

Yachi and Loreau (1999) developed the insurance hypothesis for biodiversity, where species diversity buffers ecosystem variability despite changing external environment: "... variability of ecosystem processes driven by external environmental factors generally decreases as diversity increases because of the buffering effect of asynchronous species responses (Yachi and Loreau 1997, Ives *et al.*, 1999)." (See original for references).

Results from experiments by Heneghan and Bolger (1997), on microarthropods and soil nitrogen, supported the conclusion that fluxes decrease with increasing diversity.

Folke *et al.* (2004) describe insurance in the form of ecosystem resilience to change from one stable state to another. This is insurance at regional and long-term scale: "Ecosystem

functions, being performed by species, are maintained in large-scale mosaic systems if a number of species exist that are to a large degree substitutable (Walker *et al.* 1999). Such substitutable species are regarded as being able to coexist in the landscape primarily because they have dynamics at different scales in space and time (Petersen *et al.* 1998; see also Ritchie and Olff 1999). In this way, they contribute to the resilience of the system even though they may appear to play no functional role at the moment." (Bengtsson *et al.*, 2002; see original for cited references).

"Other things being equal, the greater the mix of species in terrestrial systems, the greater the resilience of those systems implying the greater the perturbation they can withstand without losing their self-organisation. ... the value of biodiversity conservation lies in the value of the insurance it offers against catastrophic change." (Perrings *et al.*, 1995).

Redundancy in many systems is, in general, beneficial: "[A] central tenet of reliability engineering is that reliability always increases as redundant components are added to a system, a principle that directly supports redundant species as guarantors of reliable ecosystem functioning." (Bolger, 2001).

We might extrapolate from 'Junk DNA' to 'Junk species': "Much of the DNA of an organism is thought to be 'Junk DNA'; that is, DNA which plays no functional role. As an organism changes, however, it can draw upon this DNA and turn it into functioning DNA." (Gillott and Kumar, 1995).

However, the question still remains as to the usefulness of the resilient state in which the species-rich ecosystem exists, generally one of lower productivity than desired by human communities dependant upon it. We may have to fall back on the argument that in some future time (between several decades to thousands of years time), our descendents will need to adapt, in part or in whole, self-sustaining ecosystems if we are unable to afford the external inputs (e.g. fuel, NPK fertilizers, pesticides) to modify or replace their productivity. In other words, the insurance risk relates to the likelihood of resource scarcity.

Future resource scarcity

For predictions of resource scarcity there are optimists and pessimists concerning future resource availability (Krautkraemer, 2005): "In the "race" between technological progress and

diminishing marginal returns in a finite natural world, the prospects for future generations depend upon which trend is proceeding at a faster pace."

Optimists can point to the ability of technology to overcome scarcity, but this is not a guarantee for the future (Krautkraemer, 2005): "Population and economic growth into the next century will greatly increase the demand for natural resource commodities. ... The historical success of adaptation to increased demand for these commodities is by no means a guarantee of future success."

Similarly, for Sachs (2008), the Malthusian spectre cannot yet be banished: "If we indeed run out of inexpensive oil and fall short of food, deplete our aquifers and destroy remaining rain forests, and gut the oceans and fill the atmosphere with greenhouse gases that tip the earth's climate into a runaway hothouse with rising ocean levels, we might yet confirm the Malthusian curse. Yet none of this is inevitable if future technology enables us to economize on natural capital rather than finding ever more clever ways to deplete it rapidly."

At present, a viable future has been claimed, for instance, for production of methanol to replace fossil fuels (Olah *et al.*, 2006). Similarly, if energy is available relatively cheaply, then nitrogen should not be limiting as it can be manufactured via the Haber-Bosch process. However, phosphates are a non-renewable resource which may increase significantly in price in the future (Steen, 1998; White and Cordell, 2008), and there are other arguments made by 'pessimists', which point to the uncertainty of long-term success of technological solutions (e.g. Goodstein, 2004; Pfeiffer, 2006), and the need to keep pace with exponential population growth (Bartlett, 2004)[6] and growing per capita consumption (CEC, 2006). Some of the 'pessimists' even raise the possibility of future famine in some countries due to resource scarcity, and we are reminded of Bourke's (1993) analysis of how, in the 1840s famine, so many people had been manoeuvred into a position of total dependency on a resource, combined with the uncertainty concerning the biological cause of its failure: "[I]n 1846, only a minority held that potato blight

[6] "The question of how long our resources will last is perhaps the most important question that can be asked in a modern industrial society." (Bartlett *et al.*, 2004).

was caused by a fungus, and the main features of the life cycle of the fungus were not established until the results of de Bary's famous studies were published in 1861-3. The investigators of the time were groping in the dark, and the odds were heavily loaded against their grasping the essential facts out of the confusion of contradictory evidence."

Whereas in the 1840s providentialism frequently dominated socio-cultural thinking in the face of scientific uncertainty concerning the cause of potato blight (Gray, 1999), today a utilitarian land-conversion ethic[7] frequently dominates socio-cultural thinking in the face of scientific uncertainty concerning the value of species-rich but low productivity ecosystems. In both cases, biological understanding of the importance of small organisms, despite contemporary uncertainty as to their role and against a socio-cultural bias, opened (or will open) the potential for future technology to more resiliently utilise the resource in question (a potato crop or a productive ecosystem, respectively).

There are so many cases of land, water and marine management going wrong (and so widely described in both scientific and popular literature that they need not be referenced here), that the land-conversion ethic has constantly been on the defensive somewhere: soil erosion (by wind or water), lake eutrophication, river acidification, loss of flood protection, invasive species introduction, soil deficiency exacerbation, pest resurgence after pesticide use, secondary pest emergence, weed facilitation, soil structure damage (sometimes irreversible), disease vector habitat creation, disease dispersal, decline in pollinators, groundwater salinization, fish and wildlife mortality and reproductive failure, climate change, food chain disruption, harvested species habitat damage, soil and water contamination by toxic chemicals or radionucleides, nuisance species population increase, etc. The solutions to these problems, while currently often successful, are usually based on low-cost resource inputs.

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[7]See Note 2, before references.

Will we need to take components of self-sustaining, finely-tuned, species-rich, regionally-adapted land covers as part of our future land use technologies? The arguments for the biotechnology value of biodiversity have been frequently stated (e.g. Wilson, 2003), but future local land-use of ecosystems may need to combine biotechnology with ecotechnology. Itis very likely, but impossible to forecast which type or what component we might use in, say, the next 5,000 years, which is only a fraction of the probable time that it will take for them to re-evolve if completely destroyed or deeply disintegrated. Borgia (1997) has emphasised the loss of what he terms intellectual resources: "There must be an intensive effort to collect information about species before they go extinct or are relegated to reserves in degraded habitats. ... [B]iologists have been less emphatic about the unmined intellectual resources that are lost with extinction. As species go extinct and habitats are degraded, the opportunity to use natural communities as sources of information about basic physiological, ecological, and evolutionary processes is lost forever."

To lose 10% of cryptobiota species from a specific semi-natural area may be like losing a section of the natural genetic operating manual for that area (Primack, 1990). Could we, for instance, have predicted several decades ago that obscure Brazilian *Cyrtobagous* weevils would have been valuable for introduced water weed control in Australia?: "The new volumes on the weevils of Australia might seem the ultimate in esoterica to some, and who, one might ask, ever heard of a good weevil? Yet these volumes (Zimmerman 1991) contain accounts of Lake Moondara, Queensland and the river at Imbuando Village, East Sepik, Papua New Guinea. There, choking mats of the Brazilian waterweed *Salvia molesta* once virtually suffocated the natural productivity and value for fish production of these fresh water ecosystems. Introduced Brazilian *Cyrtobagous* weevils led to the virtual elimination of the exotic plant and subsequently, the waterbodies have recovered." (Lovejoy, 1994; see original for reference).

A species of moss, *Bryum pallescens* Schleich. ex Schwagr., considered rare (Smith, 2004), has developed on several large heavy metal-rich tailings impoundments in the west of Ireland, in one case laying down approx. 10,000m^3 of saturated biomass on the surface after the failure of a sown grass cover (J. A. Good, unpublished observations), this saturated wetland being the ideal cover for sulphidic tailings (Ritcey, 1989). Can we dismiss the properties of an obscure species like the very local and highly specialised moss *Discelium nudum* Dicks. (Brid.) (Smith,

2004), a frost-tolerant pioneer species of unstable clay banks (Duckett and Pressel, 2000), as never being useful in bank stability ecotechnology in the next 5,000 years? Given the speed of development of pesticide resistance in some target pests and pathogens (e.g. recently for strobilurins in cereals and cucumbers (O'Sullivan *et al.*, 2007; Ishii *et al.*, 2001)), will we always be able to rely totally on new chemical plant protection products?

A critical consideration is the length of time required to develop resilient technologies which can withstand changes in environment, while having constant variations (diversity of species) as options available to draw upon. This is not dissimilar to the variation in genetic systems upon which natural selection works. Charles Darwin, writing on artificial selection 150 years ago, emphasised the importance of time in developing adaptations to natural complexity: "How fleeting are the wishes and efforts of man! How short his time! And consequently how poor will his products be, compared with those accumulated by Nature during whole geological periods. Can we wonder, then, that Nature's productions should be far 'truer' in character than man's productions; that they should be infinitely better adapted to the most complex conditions of life, and should plainly bear the stamp of far higher workmanship?" (Darwin, 1859).

Insurance value supported

The arguments in the above sections, therefore, support option value, or ecological insurance value, of cryptobiota-rich low-productivity ecosystems, especially considering that currently unknown parts of these ecosystems may be modified to support future human needs. The importance of such insurance value was emphasised by Chapin *et al.* (2000): " Nonlinearity, uncertainty and irreversibility call for a more aggressive approach to mitigating changes in biodiversity that is now being pursued so that future options are not foreclosed."

Aldo Leopold, writing in 1953, put this insurance argument another way (cited by Primack (1993)): "If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering."

Value of site inventories and regional recording

Habitat destruction versus species disintegration

If we fully accept the insurance value of species-rich ecosystems, there still remain further steps before accepting that site inventories and regional recording are valuable activities. One is the question whether such activities are necessary if the sites are being managed for ecosystem conservation, because under such management, albeit targeted at 'flagship species', species-richness should remain intact. Marshall (2002), for instance, questioned whether forest ecosystems are disintegrated by simplifications of networks: "The forests of the world are not collapsing due to the web destroying nature of pollutants and micro-disasters which destroy a particular ecosystem by untangling the various networks that make it up, they are being destroyed by a sweeping and blanketing destruction that eliminates all members of an ecological community in near unison. Forests are mowed down in bulldozer-like fashion, rather than slowly advancing towards a state of moribund morbidity due to the surgical removal of species."

However, it is clearly incorrect to apply this conclusion universally. Most ecosystems in north-west Europe are, or will be, subject to multiple changes, such as fragmentation, land use abandonment, invasive species effects, changes in water tables, water quality deterioration, over-grazing or under-browsing, etc. An example of local extirpation of species is provided by Sutherland (1995) for the Breckland of East Anglia (England): "Some habitats have lost much of their ecological interest. For example, although much Breckland heath has been lost to forestry and agriculture there has also been a considerable loss of characteristic Breckland species from the remaining habitat (Dolman & Sutherland, 1992). … The overwhelming majority of these losses can be attributed to habitat deterioration and relatively few are due to site destruction through agriculture, afforestation and development."

Further examples are the loss of fungal species from European woodlands, probably due to nitrogen deposition (Cherfas, 1991), the decline in aradid bug diversity in Finnish forests due to fire suppression (Heliövaara and Väisänen, 1983), and the local extinction of herbivorous insect species in declining plant communities (e.g. Ward, 2004). Again, for many cryptobiota groups, there is just not enough data to show that conservation management, targeting non-cryptobiota species, will always maintain species diversity. For example, in groups like euedaphic (deep soil

layer) microarthropods, even the extent of species diversity itself is not known (André *et al.*, 1994).

The annual life cycle and lack of a dormant stage in most insects, as well as their microhabitat specialization and often poor dispersal abilities, together make many insect cryptobiota species susceptible to local extinction (Kirby, 1992). As a result, according to Stewart and New (2007): "... conservation of insect species and assemblages requires a different approach to that traditionally adopted by conservationists more concerned with plants and vertebrates, with the consequence that insects are often poorly served by the protective 'umbrella' of these more conspicuous and charismatic groups (McLean, 1990; Kirby, 1992; Hambler and Speight, 1995)." (See original for references).

Thus, the maintenance of cryptobiota species diversity cannot be taken for granted in sites protected for 'flagship' charismatic species.

Value of regional species lists

According to Srivastava and Vellend (2005), the regional species pool may be theoretically important for biological communities which are not saturated with species (as most, if not all, communities in Ireland are likely to be), although, again, evidence for this is lacking. Bengtsson *et al.* (2002) also drew attention to the importance of regional diversity (note that rare or local specialised species may often be dominant in their preferred microenvironment): "Regional diversity losses could, however, decrease local productivity in systems where productivity depends on recruitment of appropriate dominants from the regional species pool after disturbances. ... Even if no clear diversity-functioning relation (positive or negative) can be found locally, regional diversity can still be an important determinant of ecosystem processes at local sites." (Bengtsson *et al.*, 2002; see original for cited references).

The practical usefulness of regional species lists has also been well demonstrated by the predictive method used for hoverfly (Syrphidae) habitat assessment (Speight and Castella, 1995), for example by Speight (2004): "In this instance the species in the county fauna ... expected to occur in each [National] Park has been predicted ... This comparison [between predicted and

recorded fauna] suggests whether the observed fauna of each habitat is well-represented or under-represented."

Value of site inventory

The tropical ecologist, Daniel Janzen, has emphasised the importance of inventory in tropical biodiversity conservation (Janzen, 1997): "The function of detailed biodiversity inventory is *not* to choose sites for conservation. One invests inventory attention on an area that already has been seriously designated for conservation status, with the goal of ensuring that status through understanding. ..."This means that finding out which aspects of biodiversity reside in a site and getting it in order for society will involve a very large number of field taxonomists and ecologists spending their time getting their (easily inventoried) big organisms into situations where they can be poked and searched by the people who work with viruses, bacteria, fungi, mites, small insects, protozoans, parasites, algae, and other little things."

Cryptobiota naturalists excel in precise identification, thorough list-making and, with long-term patience not normally possible to the professional or academic ecologist, observing and recording rare but critical species occurrences: "Even a professional specialist can hope to make only a limited number of such discoveries in any given year for any particular kind of organism. The collaboration of amateur naturalists improves the process substantially." (Wilson 2006).

Of these critical species, sets of scarce habitat-characteristic species are considered important conservation targets by Ball (1994): "Apart from these few species [dragonfly and butterfly species] which are subject to specific guidelines, Red Data Book and other scarce species 'should be conserved as part of a rich faunal assemblage'. ... One of the main features which can be readily assessed is the presence of an assemblage of scarcer species associated with the habitats present on the site."

It is frequently the more specialised characteristic species which are the first species to be lost from ecosystems subject to human impacts (Klein, 1989; Rukke, 2000). Total species richness or diversity indices may not represent such changes in composition or structure (e.g. Connell, 1978; Dritschilo and Erwin, 1982; Hartmann and Winter, 2006), often due to the replacement of characteristic by eurytopic species in the modified ecosystem. Hence, the

importance of recognising characteristic species rather than just numbers of species or diversity indices in understanding biological deterioration of ecosystems. Here the cryptobiota naturalist has a contribution to make to the professional ecologist.

An objective of areas reserved for natural or semi-natural biodiversity is the persistence of all their characteristic species (Margules and Pressey, 2000): "Reserves, once established should promote the long-term survival of the species and other elements of biodiversity they contain by maintaining natural processes and viable populations and by excluding threats."

Objectives such as this require monitoring in some form (Elzinga *et al.*, 2001), and if cryptobiota diversity is of value, as concluded above, then the maintenance of this diversity cannot be taken for granted.

Even the findings of collectors, as separate from ecological surveyors, can be useful in evaluating the effectiveness of conservation. On 29 August 1966, Mr G. C. D. Griffiths collected seeds of marsh lousewort (*Pedicularis palustris* L.) infested with larvae of the phytomyzid fly *Phytomyza tenella* Meigen from near Mullagh More in the Burren, Co. Clare (Ireland), and subsequently reared from these a species of small ophiine braconid wasp new to science (*Ophius tenellae* Fisher) (O'Connor *et al.*, 1999). In 1986, Dr Q. D. Wheeler studied the development of a new species of leiodid beetle (*Agathidium aristerium* Wheeler) which preys on *Physarum polycephalum* Schwein, a slime-mould (myxomycete) growing on the surface of oyster mushroom (*Pleurotus ostreatus* (Jacquin: Fries) Kummer) in the Henry A. Smith Woods in Tompkins County (New York State) (Wheeler, 1987). If a specialist in each group was to return to Mullagh More in 2066, or to Henry A. Smith Woods in 2086, and rediscover these highly specialised species still living in their type localities, would that not indicate some fact about the success of biological conservation of both areas? Once a significant number of such repeat discoveries are made at a conservation site, then these accumulated records start to provide an indication of the persistence of characteristic cryptobiota assemblages.

If the cryptobiota naturalist is to make a contribution to biosphere maintenance, by inventories of small patches of that biosphere, then a number of conditions must be satisfied:- **(1)** The richness of characteristic cryptobiota species in a conserved ecosystem must be

recognised as being of value; **(2)** The disintegration of characteristic species-richness (chronic haemorrhaging of regionally-adapted information content of the ecosystem) must be possible, even with conservation management for its more recognised species; **(3)** The recording carried out by the naturalist must have the precision to identify real rather than apparent changes in species-richness; **(4)** It must be practical and feasible to respond to these changes by adaptive ecosystem management.

If any one of these steps is not possible, then the contribution by the crypobiota naturalist may be more or less insignificant. The last two steps are beyond the scope of this article, the second has been briefly discussed; but the first has been the theme, and can now be answered.

Conclusion

Biodiversity, despite its formal definition as all-embracing, appears in practice to be a socio-cultural phenomenon, as well as a property of ecosystems. Thus, the cryptobiota specialist is unlikely to contribute effectively to biodiversity conservation by emulating the species-by-species conservation of charismatic groups, because so few people are interested in cryptobiota. The only contribution of utilitarian value that appears possible is indirectly, and technically, by using species-assemblages as representatives of the functioning of components of self-sustaining, mostly low productivity, species-rich ecosystems, where those components cannot be adequately represented by plant communities and culturally-recognised wildlife species.

The justification for understanding cryptobiota diversity is the long-term insurance value of semi-natural ecosystems rich in characteristic microenvironments and characteristic species. All ecosystems, including those in conservation sites, will be more and more modified due to changing human demands. We may lose many characteristic cryptobiota species without realising it, because conservation focuses on charismatic species or ecosystem services from increasingly simplified ecosystems. Yet, our descendants may need to use parts or components of resilient self-sustaining ecosystems in the distant future to create beneficial land uses, because of scarcity of cheap resources we now take for granted. If our current dependency on

cheap resource technology is only temporary, how can we tell how important diffuse knowledge based on seemingly irrelevant recording by naturalists and biologists will be in the future?

Due to biases in public and scientific perception, combined with scientific uncertainty as to the real future role and value of cryptobiota, the cryptobiota naturalist will likely remain a 'stamp-collector' in the view of many scientists. Yet, sufficiently coordinated, data generated by such naturalists can have explanatory power. The "painstaking but unspectacular" work of site and regional inventories (Hammond, 1994), will allow some indication of changes in the diversity of local ecosystems over time. This will frequently be carried out by amateurspecialists with idiosyncratic taxonomic interests[8]. But at least, if appropriately focussed, they may take some pride in their work being a likely contribution to long-term biological insurance.

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[8]"Because of partisanship, it is pointless to debate the pros and cons of different invertebrate groups for assessing the conservation status of sites." (Foster, 1987).

Notes

1. *Use of the term cryptobiota*

Cryptobiota are defined here as species without a vernacular name. This definition is with the qualification that they are species without a vernacular name *in 1980*, because there has since been an attempt, in some countries, to give vernacular names to many species to promote their general recognition and conservation (e.g. mosses in the United Kingdom (Smith, 2004); spiders in North America (Breene, 1995)). The term 'cryptobiota' has been used elsewhere with different but related meanings (e.g. microorganisms and small invertebrates that are rarely visible to the naked eye), particularly in the Dutch literature (de Vries, 1996; Ellis, 1998; Jagers op Akkerhuis *et al.*, 2004; Bloem *et al.*, 2006). The term cyptobiotic has been used more specifically to describe arid soil crusts composed of cyanobacteria, lichens and/or mosses (e.g. Belnap, 1993). Moreno-Forero *et al.* (1998) used the term cryptobiota to describe marine fauna living in holes and crevices in the substrate (although this group may be more frequently called cryptofauna (Klumpp *et al.*, 1988; Reaka-Kudla, 1997)). Cryptobiosis, a physiological survival process in organisms such as tardigrades (Wright *et al.*, 1992), has a different meaning to cryptobiota.

Cryptobiota do not include birds, flowering plants, mammals, conifer trees, butterflies, fish, dragonflies, and many marine molluscs, crayfish, crabs and the like. They do, with relatively few exceptions (large, colourful , poisonous or edible species, or those which are pests or cause disease), include, for instance, mosses, beetles, algae, flies, most macrofungi, polychaete worms, parasitic wasps, earthworms, brittle stars, snails, lichens, sponges, amoebae, copepods, microlepidoptera, sea squirts, spiders, gastrotrichs, actinomycetes, desmids, mites, slime-moulds, nematodes, gnathostomulids and many more 'obscure' groups of tiny or microscopic organisms. They also, of course, include prokaryotes (bacteria, archaeobacteria, cyanobacteria, etc.).

2. *Definition of land conversion ethic*

The 'land conversion ethic' can be defined as the belief that it is always beneficial and sustainable to convert a natural or semi-natural land or benthic cover, water course or water

body, into a different ecological state which is human-modified and human-maintained, in order to support the needs of a growing and more affluent human population.

3. *An dearga daol*

Dineen (1927) cited *dearga daol* as a Connaught equivalent of *darbh daol*, and *dara daol* as a Munster equivalent (and Gill (1932) considered *dara* to be a corruption of *dearga*). It is tempting to think that *dearga* [red] *daol* might have referred originally to *Staphylinus dimidiaticornis* Gemminger rather than *Ocypus olens* (the devil's coach-horse); the former slightly smaller beetle with red elytra being equally abundant in parts of western Ireland, and with the same offensive stance when disturbed. If this is correct it would represent a rare (unique?) case of an insect with an Irish but not an English vernacular name.

4. *Definition of resilience*

'Resilience is defined by Folke *et al.* (2004) as "the capacity of a system to absorb disturbance and reorganise while undergoing change so as to retain essentially the same function, structure, identity and feedbacks (Walker *et al*. 2004)" (see original for reference).

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TABLE 1. Number of arthropod cryptobiota species recorded from Ireland (including offshore coastal marine area), where cryptobiota are those species without a vernacular name. The actual number of species will be much higher (see Table 2). Sources for vernacular names are indicated by '(v)'. Estimates are marked with an asterisk: for Diptera, the figure includes actual data for most families plus estimate for remaining families based on equivalent percentage (49%) of British fauna, which will be an underestimate (4000 species predicted by Ashe *et al.* (1988)); for Acari, a figure of 60% of the recorded British fauna is given as an estimate.

Taxonomic group	*Vernacular name*		*Source*
	Without	*With*	
ARTHROPODA			
Arachnida			
Acari	1240*	20	1; estimate (v)
Araneae	378	0	2; 3 (v)
Opiliones	18	0	4
Pycnogonida	19	0	5
Crustacea			
Crustacea Copepoda	767	0	6, 7, 8, 9, 10
Crustacea (other)	1048	39	5; 11 (v)
Hexapoda			
Coleoptera	2001	64	12; 13 (v)
Diptera	2953*	27	14; 15 (v)
Hymenopt. Parasitica	2437	0	16, 17, 18, 19
Lepidoptera	793	619	20; 21 (v)
Other orders	1292	195	5; estimate (v)
Myriapoda	55	4	5; estimate (v)
Tardigrada	41	0	5
Total	**13042**	**968**	

Sources: 1: Baker (2001) (Great Britain fauna - Irish fauna taken as 60%); 2: van Helsdingen (1996); 3: Jones (1983); 4: Cawley (2002); 5: DAHGI (1998); 6: Holmes (1998); 7: Holmes (2001); 8: Holmes and Gotto (1992); 9: Holmes and Gotto (2000); 10: Holmes and O'Connor (1990); 11: Campbell and Nichols (1976); 12: Anderson *et al.* (1997); 13: Harde *et al.* (1984); 14: Ashe *et al.* (1988); 15: Colyer and Hammond (1968); 16: O'Connor *et al.* (1999); 17: O'Connor *et al.* (2000); 18: O'Connor *et al.* (2004); 19: O'Connor *et al.* (2007); 20: Bond (1995); 21: Bond *et al.* (2006).

TABLE 2. Rough estimate of the number of cryptobiota species occurring in Ireland (including offshore coastal marine area), where cryptobiota are those species without a vernacular name in or about 1980. Sources for vernacular names are indicated by '(v)'. Non-cellular entities such as viruses are not included. Species numbers cited in DAHGI (1998) are roughly rounded up, taking into account species estimates for Scotland (which has basic similarities in size and gross biogeographical history to Ireland) (see Usher, 1997).

Taxonomic group	*Vernacular name*		*Source (basis for estimate)*
	Without	*With*	
Prokaryota	>20 million	50	Footnote 1, estimated (v)
Eukaryota			
Protista	20,000	50	Footnote 2, estimated (v)
Fungi	7500	164	DAHGI (1998), Phillips (1981) (v)
Algae	1500	19	DAHGI (1998), Campbell & Nicholls (1976) (v)
Bryophytes	800	10	DAHGI (1998), Footnote 3 (v)
Lichens	1200	10	DAHGI (1998), Footnote 3 (v)
Vascular plants	25	1265	Footnote 4, DAHGI (1998)
Arthropods	17,500	968	Footnote 5, Table 1
Non-arthropod invertebrates	3500	240	DAHGI (1998), Footnote 3 (v)
Vertebrates	0	466	DAHGI (1998)
Chordates (excl. vertebrates)	130	1	DAHGI (1998), Campbell & Nicholls (1976) (v)
Total (eukaryotes)	**52155**	**3243**	

1. Prokaryote species diversity has been very difficult to estimate, partly because the concept of eukaryote species does not apply to prokaryotes (Ward, 2002; Zhou *et al*., 2004). Nevertheless, Dykhuisen (1998) estimated that there are more than 1 billion species globally, and this still

appears to be acceptable (Cohan and Koeppl, 2008). Curtis *et al.* (2006) mentioned an estimate of 4 million species in one tonne of soil, and 2 million species in the ocean globally. Fenchel and Finlay (2003) noted that as organism size became smaller, an increased proportion of the global species pool would be represented locally. Thus, extrapolating between the above global estimate and that for a tonne of soil, a figure of 20 million prokaryotic species in Ireland and its surrounding seas is likely to be conservative.

2. Protist species diversity can also only be very roughly estimated (Slapeta *et al.*, 2005). Adl *et al.* (2007) estimated the potential global number of protist species to total at least 3.7 million species (including unicellular fungi). Foissner (2008) estimated approximately 300,000 free-living protists globally, of which one third may have a restricted distribution (not cosmopolitan). This latter figure does not include some species-rich parasitic or parasitoid groups listed by Adl *et al.* (2007). Usher (1997) listed a guess of 37,500 species in Scotland, noting that this could be out by an order of magnitude. Taking these estimates into account, and the high proportion of cosmopolitan species, a round figure of 20,000 protist species in Ireland can be conservatively guessed at.

3. Guides to bryophytes (Watson, 1981), lichens (Dobson, 1981) and terrestrial molluscs (Kerney and Cameron, 1979) do not mention vernacular English names, although clearly several species had these in the period around 1980. The number of species with vernacular names is therefore arbitrarily given as ten for each group, although this may overestimate bryophytes and underestimate molluscs. Species with vernacular names for marine groups are based on Campbell and Nicholls (1976); for freshwater groups on Fitter and Manuel (1986). Gut and plant parasites (nematodes, flukes, eelworms, etc.) with vernacular names are estimated at 50 based on species names associated with specific livestock and crop plants (e.g. Lapage, 1956; Buczacki and Harris, 1981; Empson and Gair, 1982).

4. It has been difficult to accurately determine the number of Irish vascular plant species without vernacular names at or before 1980. Webb (1963) mentions only a few vernacular names, and Keble-Martin (1976), for instance, omits several species with English names (such as dewberry (*Rubus caesius*) (see Fitch, 1924) and mountain avens (*Dryas octopetala*) (see

Prior, 1870). Yet, some apomictic species (e.g. several *Alchemilla* species), had then, and still lack, a vernacular name. The number of species without English names was small, and an arbitrary value of 2% has been given to the proportion of such species in the absence of more reliable information.

5. O'Connor (1997) estimated 16,000 insect species for Ireland; the estimate here for arthropods is more conservative, and assumes 25% species are unrecorded (species-rich groups like mites, nematoceran flies, parasitoid wasps, etc., are likely to have over 50% species unrecorded).

TABLE 3. Examples of microenvironments in which species from a diverse group of cryptobiota (Staphylinidae or rove-beetles) have specialised.

Microenvironment	*Species*
GEOGENIC	
Bubble-structured intertidal sandflats	*Diglotta sinuaticollis* (Mulsant & Rey)
River gravel shoals	*Brachygluta pandellei* (Saulcey)
Stream waterfalls	*Dianous coerulescens* (Gyllenhal)
Coastal eroding cliffs	*Scopaeus sulcicollis* (Stephens)
BIOGENIC	
Raptor (osprey, owls, etc.) nests	*Haploglossa picipennis* (Gyllenhal)
Rabbit burrows	*Aleochara cuniculorum* Kraatz
Lasius ant nests	*Claviger testaceus* Preyssier
Deciduous tree cavities	*Quedius truncicola* Fairemaire & Laboulbène
DECOMPOSITION	
Decomposing woodland fungi	*Proteinus atomarius* Erichson
Wetland carrion	*Atheta strandiella* (Brundin)
Seashore wrack beds	*Cafius xantholoma* (Gravenhorst)
Fresh animal dung	*Platystethus arenarius* (Fourcroy)
PLANT/MACROFUNGUS SURFACE	
Oak polypore (*Daedalia*) sporocarps	*Gyrophaena strictula* Erichson
Deciduous tree foliage	*Anthophagus caraboides* (Linnaeus)
Gorse (*Ulex*) flowers	*Philorinum sordidum* (Stephens)
Grass/herb aphid colonies	*Tachyporus chrysomelinus* (Linnaeus)

TABLE 4. Sample data, from Ireland and Great Britain, for examples of locally distributed species of staphylinid and carabid beetles showing their high relative abundance in their preferred microenvironment. Nomenclature follows Luff (2008) and Lott (2008). Abbreviations: n = number of individuals of species (Carabidae or Staphylinidae) in sample; % = percentage of total no. individuals of either Carabidae or Staphylinidae in sample; microenv. = microenvironment; loc. = locally.

Species	*n*	*%*	*Habitat / microenv.*	*Source*
Carabidae				
Bembidion clarkii (Dawson)	39	17%	Turlough pasture	1
Dyschirius obscurus (Gyllenhal)	Up to 30/m^2		Lakeshore sand	2
Staphylinidae				
Brundinia meridionalis (Muls. & Rey)	112	46%	Lagoon shore algal mat	3
Carpelimus manchuricus (Bernh.)	38	8%	Turlough pasture	1
Oxypoda tirolensis Gredler	23	40%	Montane soil	4
Platystethus nodifrons Mann.	180	36%	Turlough pasture	1
Stenus palposus Zetterstedt	Up to 10/m^2		Lakeshore sand	2
Brachygluta pandellei (Saulcey)	Loc. abundant		River gravel shoal	5
Myrmecocephalus concinnus (Er.)	Several dozen		Bracket fungi	6

Sources:- 1: Good and Butler (2001); 2: Anderson (1979); 3: Good and Butler (1998); 4: McCormack *et al*. (2006); 5: Bates and Sadler (2004); 6: Jones (2001).

SOME RECORDS FOR UNCOMMON WEEVILS (COLEOPTERA: CURCULIONIDAE), INCLUDING *SQUAMAPION ATOMARIUM* (KIRBY) NEW TO IRELAND

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Introduction

Ireland's weevil fauna has been reviewed by Morris (1993), who recognises 246 species confirmed as Irish. Since then species have been added to the Irish list by Helden (2005), McCormack (2007), Telfer (2007), Nelson (2007) and Anderson (2007). Over recent years the author has made occasional attempts to collect and identify weevils, especially in Cos Cork and Waterford. Although overall little progress was made, a few uncommon species were encountered. Details of the more interesting finds are given below, including a record for *Squamapion atomarium* (Kirby) which is an addition to the Irish fauna.

***Pseudapion rufirostre* (Fabricius)**

Collected from common mallow *Malva sylvestris* L. at the following localities:- **CORK**: Blackpool, Cork City W6773, 5 September 2004; Youghal Mudlands X1079, 31 August 2004. **LIMERICK**: Croom town park R512411, 25 July 2008. **WATERFORD**: Abbeyside X269930, 10 June 2009. **WEXFORD**: Tincone T0522, 10 September 2004.

At each of the above sites *P. rufirostre* was present in association with, and somewhat outnumbered by *Aspidapion radiolus* (Marsham). In his review of the Irish weevil fauna, Morris (1993) describes *P. rufirostre* as being local and infrequent, recorded from five vice-counties, all along the east coast, excepting North Kerry. However these new records suggest that this beetle is likely to prove widespread along the south coast.

***Squamapion atomarium* (Kirby)** **New to Ireland**

WEXFORD: Ballyteige Burrow S9405, 7 August 2004. Numerous specimens beaten from thyme *Thymus polytrichus* A. Kerner clumps in sand dunes. The specimens were identified

using Morris (1990). *S. atomarium* is a minuscule weevil, just 1.1-1.7mm in length. It is one of the few apionids which are associated with labiate plants. According to Morris (1990) it is widespread in southern Britain, and occurs widely in Eurasia and North Africa.

***Notaris bimaculatus* (Fabricius)**

WEXFORD: Castlebridge T0426, 21 June 2005. Beaten from vegetation in a salt marsh on the banks of the River Slaney. Johnson and Halbert (1902) report the species from what must be a nearby site near Wexford town. Morris (1993) lists two additional records from Cos Down and Dublin.

***Stenopelmus rufinasus* Gyllenhal**

CORK: Castlemartyr W956737, 17 October 2004. Five specimens located in a small amount of water fern *Azolla filiculoides* Lam. which was collected from a roadside stream. Added to the Irish list by Nelson (2007). Identified using Morris (2002).

S. rufinasus is a North American weevil which has become naturalized, along with its food plant *A. filiculoides* in Europe. Although now found widely in Britain, information contained in Preston *et al.* (2002) would suggest that *Azolla* is still quite rare in Ireland. No doubt there is considerable potential for increase of both fern and weevil here.

***Acalles misellus* Boheman**

CORK: Courtmacsherry Wood W524428, 6 February 2008. Among twigs and dead leaves which had accumulated between the lower branches of an oak *Quercus* in mixed deciduous woodland; Poulgorm Bridge W210353, 27 February 2008. Singleton sieved from leaf litter, collected at the edge of disturbed mixed woodland. **LAOIS**: Grantstown Wood S3380, 29 May 2007, mixed woodland. A few adults emerged from a small amount of dead wood, after this had been stored in a plastic lunchbox for a few days. **LEITRIM**: Milltown Wood G874404, 16 April 2009, among *Luzula* in mixed woodland. **LIMERICK**: Poultallin Point R239520, 24 August 2008, leaf litter in mixed woodland. **MEATH**: Hamwood N987409, 20 October 2008, leaf litter in planted woodland.

***Acalles ptinoides* (Marsham)**

WEXFORD: Kellys Wood, Camlin Hill S711255, 12 June 2008, beech *Fagus* leaf litter in

mixed woodland. **WESTMEATH**: Crookedwood N464628, 16 May 2008, leaf litter in deciduous woodland.

The author encounters *Acalles* spp whilst sieving leaf litter etc for spiders and pseudoscorpions. They are remarkably inconspicuous weevils which only make themselves apparent when they start moving, and this usually only when the sieved material is allowed to sit for an amount of time. Both of these species are described as local in Ireland by Morris (1993).

***Tanysphyrus lemnae* (Paykull)**

LEITRIM: Carrick-on-Shannon M944993, 8 April 2004. Sieved from *Carex* debris collected on the banks of the River Shannon.

A small but distinctive weevil, associated with duckweed *Lemna* sp. Listed from six vice-counties by Morris (1993 *op. cit.*), with an additional record contained in Regan and Anderson (2004).

Acknowledgement

Excepting *A. ptinoides*, Professor M. G. Morris kindly confirmed the identification of vouchers for the above records.

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WALCKENAERIA ALTICEPS (DENIS, 1952) (ARANEAE: LINYPHIIDAE) – NEW TO IRELAND FROM TWO RAISED BOGS IN CO. OFFALY

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Introduction

The first records of a spider not previously noted from Ireland, *Walckenaeria alticeps* (Denis, 1952), are detailed. *W. alticeps* is very closely related to and potentially confused with *W. antica* Wider, 1834, a species frequently reported in Ireland. An attempt is made to characterise the preferred habitat of *W. alticeps*. In addition, difficulties concerning its accurate identification are briefly discussed. All the specimens were taken from Clara and All Saints' Bogs, Co. Offaly, in 2007 and 2008 respectively. It is suggested that the woodland component present on these bogs may be of significance to the species' presence.

Site and capture details

Clara Bog, Co. Offaly (N2430), is a statutory nature reserve. Its spider fauna was investigated by the author after an award from the Heritage Council under the Wildlife Grant Scheme 2007 (WLD/2007/15538). Eight specimens of *W. alticeps* (2♂♂6♀♀) were caught in pitfall traps (n=20) set at a single station (N245304). The details are as follows:- 11 April to 3 May 2♂♂1♀; 3 May to 25 May 2♀♀; 25 May to 28 June 2♀♀; 28 June to 31 July 1♀. Traps were set in an area dominated by tracts of very wet *Sphagnum* lawn through which white beak-sedge *Rhyncosporion alba* grew abundantly. A typical bog vegetation surrounded the lawn areas, characterized by heather *Calluna vulgaris*, cross-leaved heath *Erica tetralix*, bog asphodel *Narthecium ossifragum*, deergrass *Trichophorum caespitosus* and bog cotton *Eriophorum* spp. Other species typical of midlands raised bog were also observed *viz.* sundew *Drosera rotundifolia*, oblong-leaved sundew *D. anglica* (in substantial amounts), bog rosemary

Andromeda polifolia and cranberry *Vaccinium oxycoccum*. More open pools had large growths of bogbean *Menynanthes trifoliata*. Clara Bog is known also for the presence of substantial birch *Betula* woodland on some areas but sampling was not carried out in this habitat.

All Saints' Bog, Co. Offaly (N0111), is a site of considerable interest in an Irish context due to the presence of the largest area of silver birch *Betula pendula* woodland on a raised bog in Ireland (Cross, 1987). The spider fauna was investigated on foot of an award from the Heritage Council under the Wildlife Grant Scheme 2008 (WLD/2008/16452). Twelve specimens of *W. alticeps* (7♂♂5♀♀) were caught in pitfall traps at three stations B1, B2 and W2 (10 traps per station). The details are as follows:- open bog (B1) 23 April to 23 May 3♂♂2♀♀; 23 May to 12 June 1♀, hummock/hollow bog close to woodland (B2) 23 April to 23 May 2♂♂; 23 May to 12 June 2♀♀, hummock/hollow formation in *Betula* woodland (W2) 25 April to 23 May 2♂♂. Station B1 was set in open bog and consisted of a low vegetative sward (*circa* 20cm) dominated by *C. vulgaris*, *E. cinerea* and *N. ossifragum*, with smaller amounts of other species typical of midlands raised bog e.g. *A. polifolia* and *V. oxycoccus*. *Eriophorum* grasses were present in smaller amounts as was a small quantity of *R. alba*. Some areas of the trap transect were wetter than others but no open *Sphagnum* pools were present. Station B2 was set between the main area of woodland and a substantial copse of Scots pine *Pinus sylvestris* in a relatively open area of bog. Numerous smallish (ranging to 2m) saplings of *Betula* and *Pinus* were growing in the area but some had been killed by fire. The area was wet, with some open pools dominated by *Sphagnum cuspidatum* and also some well developed moss hummocks. These were overgrown by *C. vulgaris* and *E. vaginatum*. Other plant species were *E. tetralix*, *D. rotundifolia*, *A. polifolia* and *V. oxycoccus*. Crowberry *Empetrum nigrum* was present in small amounts on the hummocks and royal fern *Osmunda regalis* was abundant locally. Station W2 was set within relatively open *Betula* woodland. Field-layer vegetation consisted of *Calluna* and some *Salix*. At ground level, the area showed good hummock/hollow formation, with *Polytrichum* moss growing in wet areas between the hummocks. Some moss hummocks were bare of other vegetation while others had a small amount of *Empetrum* or *Eriophorum* growing on them.

Raised bog and active raised bog are priority habitats under the EU Annex I habitats guide

(European Commission, 1996) and bog woodland is priority habitat under the same directive. At All Saints' Bog, the woodland is of considerable age and previously has yielded a number of interesting invertebrate finds (O'Connor and Speight, 1987; Speight, 1990). Three other spider species new to Ireland have been found at the two sites (Nolan, 2007, 2008).

The specimens of *W. alticeps* captured at Clara Bog were initially misidentified by the author as *W. antica*. It was only when *W. alticeps* had been identified (and confirmed) from All Saints' Bog that a suspicion arose about the previous identifications.Fortunately, the specimens from Clara bog had been retained and it was possible to re-examine them. *W. antica* did not appear at either site.

Identification

Wunderlich (1972) provides illustrations of the female of *W. alticeps*, separating it from *W. antica*. However using that work, males cannot be distinguished. Kronestedt (1980) provides a careful diagnosis of the distinguishing characters of the secondary genitalia of both sexes, showing that the males are also separable on morphological grounds. Roberts' (1987) illustrations of both sexes are also very clear but possibly the male features deserved a more detailed description. Females are more easily determined than the males. Through the integument, the internal structures of the genitalia appear to have three lobes in *W. alticeps* but only two in *W. antica*. When these features are not clear externally, they can be easily seen by a partial dissection of the epigyne area, showing the adnexae in dorsal view.

Kronestedt (1980) suggests that an useful feature in distinguishing males is the manner in which the embolus of *W. alticeps* tapers continuously toward its tip, including along the section from the orifice of the seminal duct (figs. 21-22) to the end-point of the embolus which is quite fine. In *W. antica*, the embolus is of nearly constant thickness along the section from the orifice of the seminal duct to the tip where it tapers quickly and has a slight kink. These features can be seen in Roberts' (1987) illustrations but he does not refer to them in the accompanying text. The orifice of the seminal duct is relatively easily seen in specimens of *W. antica* (at 80x) as a slight constriction or notch on the embolus, which then thickens to its previous width rather than

tapering gradually (Kronestedt, 1980 – figs. 18-20). These characteristics were relatively easy to see in the examined Irish specimens and were thought to be more reliable than the suggested measurements across the diameter of the coiled embolus (Roberts, 1987). In the Irish specimens the diameter of this structure ranged between 0.25 and 0.275mm, averaging at 0.269mm (17 measurements). Roberts suggests that the diameter in *W. alticeps* ranges from 0.27 to 0.31mm. It should be noted that none of the Irish specimens fell within the range suggested by Roberts for *W. antica*.

Habitat preferences

Obviously, some earlier records of *W. antica* may have been of *W. alticeps* and this situation obscures to some extent the possibility of recognising distinct habitat preferences. Kronestedt (1980) notes that the information on the preferred habitat of *W. antica*, summarised by Wunderlich (1972), may be contradictory in part because of confusion with *W. alticeps*.

In Britain, *W. alticeps* seems to be very scarce. It was first recognised there in 1982 when it was collected from a wet heath site (Merrett, 1983). The habitat with which it is generally associated in Britain is characterised as *Sphagnum* bog overgrown with *Molinia*, *Betula* and *Vaccinium myrtillus* (Harvey *et al*., 2002) and sites with moist leaf litter and shaded *Sphagnum*. This accords quite well with the Irish records, the combination of *Sphagnum* bog and taller, shading vegetation possibly being significant.

Kupryjanowicz *et al.* (1997) recorded *W. alticeps* at four out of six peat bogs in Poland. One of the sites was treeless, the others densely shaded. The species was never recorded at levels exceeding 2% of the total catch. As a result, its apparent absence at some sites does not necessarily imply it is absent from them. It was recorded in highest numbers from a site with a dense tree layer of *Pinus*. Kronestedt (1980) found the species primarily in *Sphagnum* bog, one specimen occurring near a pond in an unspecified woodland type.

A quite different habitat preference is noted however in Hänggi *et al.* (1995). These authors summarise information from twelve sources in Switzerland, Germany and Austria. The original datasheets used to compile this work are available from the authors and it was possible for the

present author to trace the records as extracted from the source papers. These gave 52 individual items of data associating *W. alticeps* with particular habitats. The greater proportion (34.6%) were from 'Waldränder' 'forest edges' – a term which receives no further explication or qualification in that work – in Switzerland. Thereafter, most records are from beech *Fagus* forest (a habitat not occurring naturally in Ireland), dry, moist and mixed (26.92%) and other forest habitats (13.46%), including dry oak *Quercus*, mixed *Quercus*, *Pinus*, spruce *Picea* (plantation) and alder *Alnus*. Most remaining records (15.38%) were from moist/wet habitats, including *Sphagnum* bog, *Carex* dominated fen, wet *Molinia* meadow, moist lake/river shores and moist (including fallow) meadows. A number were from hedges and field shrubs/trees but specimens had been taken in these situations in pitfall traps, so the species was not making use of their vertical component. Only two of the records summarised in this work were from above 800m – from *Sphagnum* bog in Austria (Freudenthaler, 1989) and fallow grassland in Switzerland.

As a result, *W. alticeps* seems to be somewhat restricted in its habitat preferences, occurring most frequently either in *Sphagnum* bogs (possibly preferring those with woodland), or broadleaf, especially *Fagus*, woodland and perhaps then preferring woodland margins. This may explain the species' scarcity generally. From its habitat preferences, its absence from a range of grasslands in northern England (Rushton, 1991) is certainly not surprising.

The significance of the Irish occurrence of *W. alticeps* in two relatively proximate (about 30k apart) midlands raised bogs is arguably enhanced by the fact that both retain a substantial element of their woodland component This habitat, historically, was almost certainly exterminated by grazing or burning from numerous other Irish raised bogs. Given the strong association of the species with woodland edge and broadleaf woodlands in parts of continental Europe, it may be the case that *W. alticeps* has maintained a presence at both Irish sites in part as a consequence of the presence of the woodland. Possibly the woodland area helps maintain a permanent population, which then may also spread into more open areas of the bog – hence the records from Clara bog and station B1 on All Saints' bog. As a habitat, or habitat component, woodland edge is extremely difficult to characterise: it may plausibly grade into almost any

other habitat e.g. lakeshore, bog, agricultural land, developed land etc and at its margins may contain almost any 'microhabitat' structures e.g. tall woody vegetation, grazed sward, ditches, human infrastructure etc. However, the number of records associated with what Hänggi *et al.* (1995) describe as woodland edge are taken here to be significant. If *W. alticeps* does have a preference for woodland edges of particular kinds, could this suggest the spider's presence deeper within some continental woodlands may be a spillover effect from the edges?

Life cycle and status

Adult females of *W. alticeps* are found in Britain from April to August and also in November with males occurring in May & November (Harvey *et al*., 2002). These dates accord broadly with the Irish records although adult males are shown to also occur in April. Traps were maintained at some stations at All Saints' bog until late in 2007 and through the winter months but they did not collect any more specimens of *W. alticeps*. The presence of adults in November suggests that the species overwinters while mature, prior to breeding the following summer. This could suggest a life-cycle similar to *W. antica* i.e. biennial, with small juveniles and then adults overwintering, mating occurring from May and egg-laying going on until August (Toft, 1978). If the two species have similar life-cycles, it could make sense that they occupy differing habitat ranges in order to avoid competition. Irish records do suggest that this is the case.

Recent Irish records of *W. antica* show that it occurs in a fairly wide range of open habitats:- lowland blanket bog (Co. Leitrim), mosses on a mountain summit (*circa* 650m) (Cawley, 2004), mosses on sand dune (Cawley, 2004, 2008). It occurred in a range of habitat types on Tory Island (Cawley, 2007):- cliff vegetation, a marshy area on cutover bog, grassy banks, heathy (*Calluna*) banks, coastal *Ammophila*, gravely cutover peat. Gibson (1982) recorded the species from fixed dunes and coastal grasslands in Co. Wexford. Neither species occurred in recent large-scale surveys of agricultural grasslands or planted forests (Anderson *et al*. 2008; Oxbrough, 2008). The presence of *W. antica* in lowland blanket bog might suggest the possibility that the two species overlap although the differences between western lowland

blanket bog and the flushed, wooded raised bogs of the midlands are very considerable. Kronestedt (1980) noted that Starega (1976) claimed to have found females of the two species in the same mountainous *Fagus* woodland in Poland and also that Wunderlich (1972) stated that the two could appear close together in mixed habitats. However Palmgren (1976) noted that *W. antica* was eurytopic and only rarely found in wet peat mosses or dense/dark woodlands.

In Britain, *W. alticeps* has recently been assigned DD (Data Deficient) status in a draft National Status Review due to uncertainty about its status (Dawson *et al*., 2008). It has been recorded at a number of sites in Wales and has a very scattered distribution throughout much of central, eastern and northern England. There are a few records from Scotland, from some of the Western Isles and also the extreme north. In Slovakia, the species is also categorised DD (Korenko, 2004) and in a red list for Flanders it is described as threatened with extinction (http://www. inbo.be/content/page.asp?pid =FAU_ SPI_start).

W. alticeps is widely distributed through Europe, although it does not occur in either Norway, Finland, or on any of the Mediterranean islands or European territories (Hesldingen, 2009) but the species is found as far east as Iran (Platnick, 2009).

Its occurrence in a habitat of significant rarity in Ireland suggests that the species may be of some conservation interest and further enhances the status of the sites in which it was found.

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A SUMMARY OF NEW IRISH COUNTY RECORDS FOR SPIDERS (ARANEAE)

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Abstract

A total of 2354 new county records for Irish spiders, involving 355 species, are summarised. These records are drawn from both published and unpublished information, with published sources being numbered to allow for easy traceability. The present state of recording of Irish spiders at the county level is summarised in tabular form.

Introduction

Helsdingen (1996a) listed over 3500 county records for spiders from Ireland's 32 counties. This includes a handful of county records for *Entelecara media* Kulczyński, *Zelotes longipes* (L. Koch) and *Hypsosinga sanguinea* (C. L. Koch), spiders subsequently deleted from the Irish list by Cawley (2004) and Nolan (2004). In addition Helsdingen lists county records for a few species of uncertain nomenclature, which he indicates using a question mark (?), and for some imported species which he denotes using an asterisk (*).

The opportunity is taken here to summarise in one paper a substantial number of new county records which have been gathered over recent years. Many of these have been mentioned in the publications of Anderson *et al.* (2008), Cawley (2001, 2004, 2007, 2008), Cawley and Nolan (2007), Fahy and Gormally (2003), Helsdingen (1996b, 1997, 1998), Johnston and Cameron (2002a, b), McCormack, Nolan and Regan (2006), McFerran (1997), Merrett (2000), Nelson (2005), Nolan (2000a, b, 2002a, b, 2007a, b, 2008, 2009), Nolan and McCormack (2004), Nolan and Regan (2008), O'Meara (2002), Oxbrough (2007, 2008), Smith (1999), Smith and Costello (1999), Snazell, Jonsson and Stewart (1999) and Speight *et al.* (2000). A small number of previously overlooked published records, contained in Merrett (1975, 1982, 1989, 1995) and Speight (1990) are also included. References are numbered so that the source of published records can be easily traced. The great majority of unpublished records are backed by

specimens in the author's collection, and these will eventually be donated to the National Museum of Ireland. These unpublished records are shown in **bold** print.

No less than 40 species have been added to the Irish list since the appearance of Helsdingen (1996a). These are indicated below by the use of an asterisk (*). An additional spider of uncertain status in Ireland, *Segestria florentina* (Rossi), reported by Nolan (2008) is designated using the hash symbol (#). Nomenclature and sequence follows Merrett and Murphy (2000), except that *Troxochrus scabriculus* f. *cirrifrons* (O. P.-Cambridge) is listed as a separate taxon. Consequently *Pelecopsis nemoralioides* (O. P.-Cambridge) and *Pardosa agrestis* (Westring) are treated here, for convenience, as species distinct from *Pelecopsis nemoralis* (Blackwall) and *Pardosa purbeckensis* F. O. P. -Cambridge respectively. Also, to facilitate ease of use, species are listed alphabetically within each family. In both the discussion, and Table 1, numbers preceding a plus (+) sign refer to the number of county records contained in Helsdingen (1996a), and numbers after a plus sign refer to the number of new county records mentioned in this publication. The handful of deletions contained in Cawley (2004) and Nolan (2004) have also been factored into the table. In the following list, new county records are summarised using the following abbreviations. ANT = Antrim, ARM = Armagh, CAR = Carlow, CAV = Cavan, CLA = Clare, COR = Cork, DER = Derry, DON = Donegal, DOW = Down, DUB = Dublin, FER = Fermanagh, GAL = Galway, KER = Kerry, KLD = Kildare, KLK = Kilkenny, LAO = Laois, LEI = Leitrim, LIM = Limerick, LNF = Longford, LOU = Louth, MAY = Mayo, MEA = Meath, MON = Monaghan, OFF = Offaly, ROS = Roscommon, SLI = Sligo, TIP = Tipperary, TYR = Tyrone, WAT = Waterford, WES = Westmeath, WEX = Wexford and WIC = Wicklow.

LIST OF SPECIES

PHOLCIDAE

***Pholcus phalangioides* (Fuesslin)**

CAV, DON (4), **FER**, **GAL**, **KLD**, **LAO**, **LEI**, **LNF**, **LOU**, **MAY**, **MEA**, **MON**, **OFF**, **ROS**, **SLI**, **TYR**, **WES**, **WIC**.

***Psilochorus simoni* (Berland)**

DUB (27).

SEGESTRIIDAE

#***Segestria florentina* (Rossi)**

DUB (31).

***Segestria senoculata* (L.)**

CAV, **KLD**, LIM (37), OFF (37), **ROS**, **TYR**.

DYSDERIDAE

***Dysdera crocata* C. L. Koch**

ROS, **SLI**.

***Harpactea hombergi* (Scopoli)**

CAV, LAO (3), **LIM**, **LNF**, **MON**, **OFF**, **WES**.

OONOPIDAE

****Oonops domesticus* Dalmas**

COR (38), DON (4), DUB (24), SLI (2), WIC (24).

***Oonops pulcher* Templeton**

KLD, **LIM**, **LNF**, **LOU**, **MAY**, MEA (5), **OFF**, **SLI**, **TIP**, **TYR**, WAT (3), **WES**, **WEX**.

MIMETIDAE

***Ero cambridgei* Kulczyński**

CAV, DON (4), LEI (3), LIM (37), **LNF**, MAY (37), **MEA**, WAT (3), WES (12), WIC (37).

***Ero furcata* (Villers)**

ARM (13), DON (4), FER (13), KLD (30), LIM (37), ROS (16), **WES**.

ULOBORIDAE

***Hyptiotes paradoxus* (C. L. Koch)**

KER (2). A record cited in O'Meara (2002) is clearly erroneous.

NESTICIDAE

***Nesticus cellulanus* (Clerck)**

CAV (5), **DON**, **LAO**, **LEI**, **ROS**, **SLI**, **TIP**, WAT (3), **WEX**, WIC (37).

THERIDIIDAE

***Achaearanea lunata* (Clerck)**

LAO (3).

***Anelosimus vittatus* (C. L. Koch)**

CAV (5), COR (3), GAL (5), KLK (3), **LAO**, **LNF**, **WAT**, **WES**.

***Dipoena tristis* (Hahn)**

COR.

******Enoplognatha latimana* **Hippa and Oksala**

COR (3), WAT (3).

***Enoplognatha ovata* (Clerck)**

CAV, **MON**.

***Enoplognatha thoracica* (Hahn)**

DON (5), FER (16), MEA (5), MON (5), **ROS**, **SLI**, **TIP**, WEX (25), **WIC**.

***Episinus angulatus* (Blackwall)**

KLD (11), **KLK**, LEI (3), LOU (5), MEA (5), ROS (5), **SLI**.

***Episinus truncatus* Latreille**

COR (37).

***Euryopis flavomaculata* (C. L. Koch)**

ANT (14), DOW (16), LEI (3), MAY (37), WAT (37).

***Neottiura bimaculata* (L.)**

CAR (16), KLK (3), LEI (3), **LNF**, LOU (5), **SLI**, TIP (37), TYR (14), WAT (37), WEX (25).

***Paidiscura pallens* (Blackwall)**

DER, **LAO**, **LEI**, **LOU**, **MON**, **TYR**, **WAT**.

***Pholcomma gibbum* (Westring)**

CAV (5), **DER**, DON (4), KLD (11), **LEI**, LIM (37), **LNF**, **MAY**, MEA (5), ROS (5), TIP

(37), WAT (3), WEX (25), WIC (37).

***Robertus arundineti* (O. P. -Cambridge)**

CAV (5), COR (5), DON (4), FER (21), KER (37), LEI (3), **LIM**, LOU (5).

***Robertus lividus* (Blackwall)**

LAO (37), LEI (37), **MEA**, OFF (10), WAT (3).

***Robertus neglectus* (O. P. -Cambridge)**

ANT (13), CLA (37), KLD (1), KLK (37).

***Rugathodes instabilis* (O. P. -Cambridge)**

CAV (5), **DON**, GAL (5), KLK (3), LAO (37), LEI (37), **MEA**, OFF (37), SLI (3), TIP (37), WAT (3), WES (12), WIC (37).

******Simitidion simile* (C. L. Koch)**

KLK (3).

***Steatoda grossa* (C. L. Koch)**

DOW, DUB (2), KER (3), **LIM**, SLI (2), WAT (3) WIC (24).

******Steatoda nobilis* (Thorell)**

COR (2), DUB (27), **LIM**, WIC (24).

***Theonoe minutissima* (O. P. -Cambridge)**

CAR (37), **CAV**, COR (3), **DER**, FER (37), KER (37), LAO (37), **LEI**, LIM (37), MAY (15), **ROS**, **SLI**, **TYR**, WAT (37), WEX (37), WIC (26).

***Theridion impressum* L. Koch**

DON, DOW (19), FER (37), KLK (37), TIP (37), TYR (23), **WAT**.

***Theridion mystaceum* L. Koch**

CAV, COR (27), **DON**, DUB (27), **KLD**, KLK (3), **LAO**, **LEI**, **LIM**, **MEA**, **MON**, **ROS**, SLI (2), **TIP**, **WAT**, **WES**, WEX (2), WIC (26).

It seems likely that many published records for *Theridion melanurum* Hahn refer to this species.

***Theridion sisyphium* (Clerck)**

CAV, **MEA**, **MON**, SLI (3).

***Theridion tinctum* (Walckenaer)**

DUB (5), KLK (3), TIP (5).

These constitute the first authentic Irish records for this spider.

***Theridion varians* Hahn**

CAV, **GAL**, **KLD**, KLK (5), **LAO**, **MON**, TIP (37), **WES**, **WEX**.

THERIDIOSOMATIDAE

***Theridiosoma gemmosum* (L. Koch)**

FER (3), KLD (11), KLK (2), LAO (3), LEI (3), LIM (37), **LNF**, ROS (3), SLI (2), TIP (37), WAT (3), **WEX**.

LINYPHIIDAE

***Agyneta cauta* (O. P. -Cambridge)**

DON (4), FER (21), GAL (37), KER (37), MAY (37).

***Agyneta conigera* (O. P. -Cambridge)**

ARM (16), CAV (5), COR (3), DON (4), KER (37), KLK (37), LIM (37), **LOU**, MAY (37), **MEA**, OFF (37), **SLI**, TIP (37), **WAT**, WEX (25), WIC (37).

***Agyneta decora* (O. P. -Cambridge)**

ARM (23), CLA (37), COR (37), DON (4), KLK (37), LAO (37), LIM (37), MAY (37), MEA (1), SLI (3), TIP (37), WAT (37), WES (37), WEX (25), WIC (26).

***Agyneta olivacea* (Emerton)**

CAV (5), CLA (37), COR (37), DON (15), GAL (37), KER (37), **KLK**, LAO (37), LEI (37), LIM (37), MAY (37), SLI (5), TYR (23), WAT (37), WIC (26).

******Agyneta ramosa* **Jackson**

CAR (37), CLA (37), COR (37), DON (37), DUB (37), GAL (7), KER (37), KLK (37), LAO (37), LEI (37), LIM (5), MAY (37), TIP (37), WAT (37), WEX (5), WIC (37).

***Agyneta subtilis* (O. P. -Cambridge)**

KLD (37), KLK (37), LAO (37), LEI (37), LIM (37), OFF (10), SLI (37), WAT (37), WES (37), WEX (25).

***Allomengea scopigera* (Grube)**

ARM (23), FER (21), KER (37), TYR (14), WAT (2).

***Allomengea vidua* (L. Koch)**

ARM (23), FER (16), LIM (37), MON (5), OFF (10), **SLI**, WEX (25).

***Aphileta misera* (O. P. -Cambridge)**

CAV (5), COR (37), DER (14), DOW (14), FER (13), KER (37), **LNF**, **MON**, SLI (2), TYR (13), WES (12), WEX (25).

***Araeoncus crassiceps* (Westring)**

ARM (23), DOW (23), GAL (37), KER (37), LEI (3), MAY (37), **WAT**, WES (12), WEX (25).

***Araeoncus humilis* (Blackwall)**

LNF, WEX (25).

***Asthenargus paganus* (Simon)**

CLA (5), COR (17), DUB (37), FER (37), GAL (5), KLD (37), KLK (37), LAO (37), LIM (37), **LNF**, **ROS**, SLI (3), TIP (5), TYR (5), **WES**, WAT (2), WEX (37), WIC (37).

***Baryphyma gowerense* (Locket)**

CLA (36), GAL (36), KLD (11), OFF (10), SLI (3), WEX (5).

***Baryphyma trifrons* (O. P. -Cambridge)**

DON (4), KLD (11), KLK (37), LAO (37), LEI (37), LIM (37), MAY (37), OFF (10), ROS (3), SLI (3), **WAT**.

***Bathyphantes approximatus* (O. P. -Cambridge)**

ARM (23), **CAV**, DON (4), LAO (37), LEI (3), **LNF**, **MEA**, OFF (10), SLI (3), TYR (23), WES (12), WEX (25).

***Bathyphantes gracilis* (Blackwall)**

LIM (37), **LNF**, **LOU**, SLI (3), TYR (23).

***Bathyphantes nigrinus* (Westring)**

COR (39), **DON**, LAO (37), LEI (37), LIM (37), OFF (37), SLI (37), **TYR**.

***Bathyphantes parvulus* (Westring)**

ARM (23), CLA (37), COR (37), DUB (37), GAL (37), KER (37), KLD (11), KLK (37), LEI

(37), LIM (37), MAY (37), OFF (10), **ROS**, **SLI**, TIP (37), WAT (3), WES (12), WEX (25).

***Bathyphantes setiger* F. O. P. -Cambridge**

DOW (23), GAL (37), OFF (10), TYR (14), WEX (5).

******Bolyphantes alticeps* **(Sundevall)**

DUB (24).

***Bolyphantes luteolus* (Blackwall)**

FER (21), **LNF**, **SLI**, **WAT**.

******Carorita limnaea* **(Crosby and Bishop)**

WES (12).

***Carorita paludosa* Duffey**

DOW (23), LEI (3), **LNF**, MON (5), SLI (3).

***Centromerita bicolor* (Blackwall)**

COR, KLD (1).

***Centromerita concinna* (Thorell)**

CAV (5), COR (3), FER (21), LAO (37), LEI (3), **LIM**, **LNF**, MEA (5), MON (5), ROS (5), SLI (15), WAT (3), WEX (25), WIC (26).

******Centromerus albidus* Simon**

GAL (5).

***Centromerus arcanus* (O. P. -Cambridge)**

WAT (37), WIC (26).

***Centromerus dilutus* (O. P. -Cambridge)**

CAV (5), COR (39), **DER**, DON (4), FER (37), KER (37), KLD (37), LEI (3), LIM (37), **LNF**, **LOU**, MAY (15), **MEA**, **ROS**, SLI (37), TYR (5), WAT (37), **WES**, WEX (25), WIC (26).

******Centromerus levitarsis* (Simon)**

KLD (11).

***Centromerus prudens* (O. P. -Cambridge)**

ANT (16), COR (3), DER (16), LIM (37), SLI (15), WEX (25).

***Centromerus sylvaticus* (Blackwall)**

LIM (37), TIP (37), **TYR**, WIC (37).

***Ceratinella brevipes* (Westring)**

ANT (19), ARM (23), CAV (5), COR (3), DON (15), DOW (23), LIM (37), **LNF**, **LOU**, MEA (1), OFF (10), **ROS**, SLI (3), WAT (37), WIC (26).

***Ceratinella brevis* (Wider)**

CAR (37), FER (21), GAL (5), KLD (30), LEI (37), LIM (37), **LNF**, MAY (37), WAT (37).

***Ceratinella scabrosa* (O. P. -Cambridge)**

CAV (5), COR (37), GAL (5), KLD (37), KLK (37), LAO (37), LEI (37), LIM (37), **LOU**, OFF (37), **ROS**, WAT (37), WES (37), WEX (37), WIC (37).

***Cnephalocotes obscurus* (Blackwall)**

ARM (23), COR (3), DON (37), DUB (37), FER (21), **GAL**, LEI (37), **LNF**, MEA (5), OFF (37), **SLI**, WAT (3).

***Dicymbium brevisetosum* Locket**

MAY, **SLI**, **WES**, WEX (25).

***Dicymbium nigrum* (Blackwall)**

COR (37), KLD (1), LEI (37), LIM (37), **LNF**, **ROS**, SLI (3), WAT (37).

***Dicymbium tibiale* (Blackwall)**

CLA (37), COR (3), DUB (37), FER (16), GAL (37), KER (37), KLD (37), LAO (37), LIM (37), MAY (15), OFF (37), SLI (37), TIP (37), WAT (3), WEX (37), WIC (26).

***Diplocentria bidentata* (Emerton)**

DON (15), MAY (15), WAT (37).

***Diplocephalus cristatus* (Blackwall)**

FER (21), **KLK**, **WAT**.

***Diplocephalus latifrons* (O. P. -Cambridge)**

COR (17), DON (37), GAL (37), LAO (37), **LEI**, LIM (37), **LOU**, MEA (1), **ROS**, SLI (37), TIP (37), **TYR**, WAT (37), WEX (37), WIC (37).

***Diplocephalus permixtus* (O. P. -Cambridge)**

CAV, DON (4), DUB (37), LIM (37), **LOU**, MAY (37), OFF (10), ROS (3), TYR (5), WIC (26), WES (12).

***Diplocephalus picinus* (Blackwall)**

CAV (5), **COR**, **DER**, **DON**, KLD (37), **KLK**, LEI (37), **LNF**, **LOU**, **MON**, OFF (37), SLI (3), **TIP**, **TYR**, **WES**, WIC (37).

***Diplostyla concolor* (Wider)**

COR (3), LAO (37), OFF (10), **TYR**, WAT (37), WES (37).

***Dismodicus bifrons* (Blackwall)**

CAV (5), DON (15), KLD (11), KLK (37), LEI (37), LIM (37), LOU (5), **MEA**, OFF (37), SLI (15), WAT (37), WES (37), WEX (25).

***Donacochara speciosa* (Thorell)**

LEI (3), WAT (3).

***Drapetisca socialis* (Sundevall)**

CAV (5), **KER**, **LEI**, **MON**, SLI (3).

***Drepanotylus uncatus* (O. P. -Cambridge)**

DON (37), **SLI**, WES (12), WEX (25), WIC (26).

***Entelecara erythropus* (Westring)**

CAR (16), **CAV**, FER (16), KLK (3), **LAO**, **LIM**, **SLI**, WAT (3), **WEX**.

******Entelecara flavipes* (Blackwall)**

COR (3).

***Erigone arctica* (White)**

WAT.

***Erigone atra* Blackwall**

LEI (3), **LNF**, **LOU**.

***Erigone dentipalpis* (Wider)**

KLK (37), LAO (37), **LEI**, **LNF**, **LOU**, **TYR**, WIC (37).

***Erigone longipalpis* (Sundevall)**

CAR (37), OFF (10), TIP (37), WAT (37).

***Erigone promiscua* (O. P. -Cambridge)**

SLI (15), **WAT**.

***Erigonella hiemalis* (Blackwall)**

COR (17), KER (37), KLD (37), **KLK**, LAO (37), **LEI**, LIM (37), **MAY**, MEA (1), SLI (15), **TYR**.

***Erigonella ignobilis* (O. P. -Cambridge)**

CAV, COR (3), FER (13), KER (37), MON (5), OFF (10), ROS (3), WAT (37), WES (12).

***Evansia merens* O. P. -Cambridge**

COR (3), KER (27), LNF (5), WAT (5).

***Floronia bucculenta* (Clerck)**

COR (3), DOW (23), WEX (25).

***Glyphesis cottonae* (La Touche)**

OFF (31).

***Gnathonarium dentatum* (Wider)**

LEI (3), **LNF**, **MEA**, MON (5), ROS (3), SLI (3).

***Gonatium rubellum* (Blackwall)**

CLA, COR (17), KER (17), **LEI**.

***Gonatium rubens* (Blackwall)**

CAV, COR (3), DON (4), **LEI**, **LIM**, **LNF**, MEA (5), **MON**, **SLI**, WAT (3).

***Gongylidiellum latebricola* (O. P. -Cambridge)**

DER (14), DON (37), GAL (37), KER (37), **LNF**, LOU (5).

***Gongylidiellum murcidum* Simon**

COR (3), **GAL**, ROS (3).

***Gongylidiellum vivum* (O. P. -Cambridge)**

CAV (5), COR (17), DUB (37), FER (21), KLD (30), LEI (3), LIM (37), **LNF**, **LOU**, MEA (1), **MON**, OFF (10), ROS (3), SLI (3), TYR (5), WAT (3), WEX (25), WIC (37).

***Gongylidium rufipes* (L.)**

CAV (5), GAL (5), KER (37), KLD (11), KLK (37), **LEI**, **LOU**, **MEA**, **MON**, **SLI**, TYR (16), **WES**, WIC (37).

***Halorates reprobus* (O. P. -Cambridge)**

LEI, **LIM**, **SLI**, **WAT**, **WEX**.

***Helophora insignis* (Blackwall)**

CAV, **KLK**, **LNF**, **MAY**, **MEA**, **TYR**.

***Hilaira excisa* (O. P. -Cambridge)**

CAR (37), COR (39), DON (37), DUB (37), GAL (37), KER (37), LAO (37), LIM (37), TIP (37).

***Hilaira frigida* (Thorell)**

COR (3), DON (15), FER (13), LEI (5), MAY (15), SLI (2).

***Hilaira pervicax* Hull**

DER (14).

***Hylyphantes graminicola* (Sundevall)**

COR (3), GAL (5), **LAO**, **LIM**, **TIP**, WES (5).

***Hypomma cornutum* (Blackwall)**

CAV, **COR**, DOW (23), KLK (5), **LEI**, **LNF**, **MON**, **SLI**, **WAT**.

***Hypomma fulvum* (Bösenberg)**

ARM (23), DOW (23), **KLD**, LEI (3), **LNF**, **MEA**, **MON**, ROS (3), SLI (2), WAT (3).

***Hypselistes jacksoni* (O. P. -Cambridge)**

DON (37), KER (37), **LEI**, WIC (37).

***Jacksonella falconeri* (Jackson)**

KLD (30), LEI (3), SLI (15), TYR (5).

***Kaestneria dorsalis* (Wider)**

CAV (5), **LIM**, **LNF**, LOU (5), **MON**, OFF (10), **WAT**.

***Kaestneria pullata* (O. P. -Cambridge)**

DON (37), DOW (23), GAL (37), KER (37), KLK (37), **LNF**, MAY (37), **MEA**, MON (5),

OFF (37), ROS (3), **SLI**, TIP (37), TYR (23), **WAT**, WES (12).

***Labulla thoracica* (Wider)**

CAV, **DON**, **LIM**, **LOU**, **SLI**.

***Latithorax faustus* (O. P. -Cambridge)**

DON (15), **FER**, MAY (15), SLI (15).

***Lepthyphantes alacris* (Blackwall)**

CAV (5), DON (4), DUB (37), KLD (37), KLK (37), LAO (37), LEI (37), LIM (37), **LNF**, MAY (37), **ROS**, SLI (37), TIP (37), TYR (5), WAT (3), **WES**, WEX (37), WIC (37).

***Lepthyphantes angulatus* (O. P. -Cambridge)**

LEI (3), **ROS**, SLI (3), **TYR**.

***Lepthyphantes cristatus* (Menge)**

ARM (16), COR (39), DON (4), FER (21), **KER**, LAO (37), LEI (37), **LIM**, **OFF**, **SLI**, TIP (37), TYR (5), WAT (37).

***Lepthyphantes ericaeus* (Blackwall)**

DER, DON (15), KLK (37), LEI (37), **LNF**, MEA (5), ROS (3), SLI (3), **TYR**.

***Lepthyphantes flavipes* (Blackwall)**

CAV, CLA (37), KER (37), KLD (37), KLK (37), LEI (37), LIM (37), **LNF**, **LOU**, MAY (42), **MEA**, **MON**, SLI (37), TYR (23).

***Lepthyphantes insignis* O. P. -Cambridge**

WEX (1).

***Lepthyphantes mengei* Kulczyński**

ARM (23), DOW (19), LEI (37), LIM (37), **LNF**, **ROS**, WAT (37), WIC (26).

***Lepthyphantes minutus* (Blackwall)**

KLD, **LIM**, **LOU**, **ROS**, **WAT**.

***Lepthyphantes obscurus* (Blackwall)**

CAV (5), GAL (37), KLD (37), KLK (3), **LEI**, LIM (37), LOU (5), **ROS**, **SLI**, TIP (37), **WAT**, **WES**, WEX (25), WIC (37).

***Lepthyphantes pallidus* (O. P. -Cambridge)**

ANT (21), FER (13), KLK (37), LAO (37), LEI (37), LIM (37), SLI (37), TYR (13), WAT (37), WIC (37).

***Lepthyphantes tenebricola* (Wider)**

CAR (37), CLA (37), DON (15), DUB (37), GAL (37), KER (37), KLD (37), KLK (37), LAO (37), LEI (37), LIM (37), SLI (37), TIP (37), WAT (37), WES (37), WEX (37), WIC (37).

***Lepthyphantes tenuis* (Blackwall)**

DON (15), **LNF**, **MON**, WAT (3).

***Lepthyphantes whymperi* F. O. P. -Cambridge**

MAY (15).

***Lepthyphantes zimmermanni* Bertkau**

LIM (37), **LNF**, **MEA**, **MON**, WEX (25).

***Leptorhoptrum robustum* (Westring)**

COR (37), KLK (37), LEI (37), LIM (37), MEA (1), OFF (37), SLI (37), **TYR**, WAT (37), WES (37), WEX (1).

***Linyphia hortensis* Sundevall**

ANT (16), **CAV**, **COR**, KLD (37), **LAO**, **LEI**, **MON**.

***Linyphia triangularis* (Clerck)**

KLD (30), **LAO**, **MON**.

***Lophomma punctatum* (Blackwall)**

ARM (23), COR (39), DON (15), DOW (23), KLK (37), LEI (37), LIM (37), **LNF**, MAY (37), MON (5), OFF (10), SLI (3), WAT (3), WES (12), WEX (25).

***Macrargus rufus* (Wider)**

LAO (37), WIC (37).

******Maro minutus* **O. P. -Cambridge**

CAR (37), CLA (37), COR (37), DON (4), DUB (37), KER (37), KLD (37), LAO (37), LEI (5), LIM (37), MAY (37), SLI (3), TIP (37), WEX (25), WIC (37).

***Maro sublestus* Falconer**

GAL (6), LEI (3), **LNF**, MAY (15), OFF (10).

***Maso sundevalli* (Westring)**

ARM (13), CAV (5), DON (4), LEI (3), **LNF**, **LOU**, **MON**, ROS (3), **SLI**, WAT (37), WES (12), WIC (37).

***Mecopisthes peusi* Wunderlich**

MEA (18).

***Mecynargus morulus* (O. P. -Cambridge)**

COR (3), DER (14), DON (15), LEI (5), MAY (15), SLI (2), WAT (3), WIC (26).

***Megalepthyphantes nebulosus* (Sundevall)**

OFF (37).

***Meioneta beata* (O. P. -Cambridge)**

DON (37), TYR (14).

***Meioneta gulosa* (L. Koch)**

SLI (15).

Meioneta mollis* (O. P. -Cambridge)

KER (36).

Meioneta mossica* Schikora

DON (15), SLI (33).

***Meioneta rurestris* (C. L. Koch)**

COR (37), KLK (1), **LOU**, MEA (1), WAT (1), WEX (1), WIC (1).

***Meioneta saxatilis* (Blackwall)**

CLA (37), DUB (37), GAL (37), KLK (37), LAO (37), OFF (37), TIP (37), WAT (37), WES (37), WEX (25).

***Metopobactrus prominulus* (O. P. -Cambridge)**

ARM (13), CAR (37), CLA (37), COR (37), DER (13), DON (37), FER (13), KER (37), KLK (37), LAO (37), **LEI**, **LIM**, TIP (37), TYR (14), WAT (2), WEX (37), WIC (26).

***Micrargus herbigradus* (Blackwall)**

ARM (23), CAR (37), COR (17), DON (15), DUB (37), FER (21), GAL (37), KER (37), KLD (37), LAO (37), LEI (37), LIM (37), MAY (15), OFF (10), ROS (5), SLI (15), TIP (37), WAT (37), WES (12), WEX (37), WIC (26).

***Micrargus subaequalis* (Westring)**

COR (37), DON (4), FER (21), GAL (37), KLK (37), LAO (37), LIM (37), **LOU**, **MON**, OFF (10), **ROS**, SLI (3), TYR (14), WAT (37), WES (37), WEX (25), WIC (37).

***Microctenonyx subitaneus* (O. P. -Cambridge)**

COR (2), FER (3), **KER**, **KLD**, KLK (3), LAO (3), **LIM**, **LNF**, **MAY**, **OFF**, SLI (3), **TIP**, WAT (3).

***Microlinyphia impigra* (O. P. -Cambridge)**

COR (3), **MEA**, ROS (3), SLI (3), WES (12).

***Microlinyphia pusilla* (Sundevall)**

DON (4), LEI (3), LIM (37), **MEA**, SLI (15).

***Microneta viaria* (Blackwall)**

ARM (13), CAV (5), COR (17), **DON**, FER (16), KLD (37), **LEI**, **LNF**, **MAY**, **MEA**, **MON**, **ROS**, TYR (13), **WES**.

***Milleriana inerrans* (O. P. -Cambridge)**

COR (27), KER (37), LIM (36).

***Minicia marginella* (Wider)**

OFF (29).

***Minyriolus pusillus* (Wider)**

CAV, **COR**, KER (17), KLD (30), **KLK**, **LEI**, **LIM**, **LNF**, SLI (15), TYR (5), WAT (37), WIC (37).

***Mioxena blanda* (Simon)**

WEX (31).

***Monocephalus castaneipes* (Simon)**

ANT (16), CAV (5), COR (37), **DER**, **GAL**, KER (17), **KLD**, **KLK**, **LAO**, **LEI**, **LIM**, **LNF**,

MON, ROS (5), SLI (37), **TIP**, **TYR**, **WAT**, **WEX**, WIC (37).

***Monocephalus fuscipes* (Blackwall)**

ARM (23), LAO (37), LEI (37), LIM (37), **LOU**, **MEA**, WAT (37), WES (37).

***Neriene clathrata* (Sundevall)**

CAV (5), LEI (37), **LNF**, WES (12).

***Neriene montana* (Clerck)**

LEI (37), LIM (37), **MON**, TYR (13), WEX (25).

***Neriene peltata* (Wider)**

CAV (5), COR (37), **LEI**, LIM (37), **LOU**, **MON**.

***Oedothorax agrestis* (Blackwall)**

DER (16), **WAT**.

***Oedothorax apicatus* (Blackwall)**

WEX (1).

***Oedothorax fuscus* (Blackwall)**

LAO (37), **LNF**, **LOU**, TYR (23), WIC (37).

***Oedothorax gibbosus* (Blackwall)**

CAV, DUB (37), KER (37), KLK (37), LEI (3), LIM (37), MAY (37), **MEA**, MON (5), OFF (10), ROS (3), SLI (3), TIP (37), WAT (3), WES (12), WEX (25).

***Oedothorax retusus* (Westring)**

DON (15), FER (21), KLD (37), LIM (37), **LNF**, MEA (5), OFF (10), WAT (37), WES (12).

***Oreonetides vaginatus* (Thorell)**

DON (15), MAY (15).

***Ostearius melanopygius* (O. P. -Cambridge)**

COR (2), DOW (13), FER (13), KLK (1), **LAO**, **LIM**, **LNF**, **LOU**, MEA (1), SLI (2), WAT (3), WEX (2).

***Pelecopsis mengei* (Simon)**

LEI (37), ROS (5), SLI (3), TYR (23), WIC (37).

***Pelecopsis nemoralioides* (O. P. -Cambridge)**

DON (4), WAT (3).

***Pelecopsis nemoralis* (Blackwall)**

CAV (5), CLA (37), COR (37), **DER**, **KLK**, LIM (37), **SLI**, WEX (25), WIC (37).

The above unpublished records refer to females, treated as *P. nemoralis* rather than *P. nemoralioides* following the approach of Harvey *et al*. (2002).

***Pelecopsis parallela* (Wider)**

COR (2), DON (37), DOW (16), KER (37), LIM (37), WAT (2), WEX (1), WIC (37).

***Peponocranium ludicrum* (O. P. -Cambridge)**

ARM (13), **CAV**, FER (13), GAL (37), KLD (30), LEI (3), LIM (37), **LNF**, LOU (5), ROS (5), SLI (15), TYR (13), WAT (37), WEX (25).

***Pocadicnemis juncea* Locket and Millidge**

ANT (23), ARM (16), CLA (37), COR (37), DON (37), DUB (37), FER (37), GAL (37), KER (37), KLK (37), LAO (37), LEI (37), LIM (5), MAY (37), OFF (10), SLI (3), TIP (37), WAT (37), WES (37), WEX (1), WIC (37).

***Pocadicnemis pumila* (Blackwall)**

COR (3), KER (37), LEI (37), LIM (37), MEA (5), WEX (25).

***Poeciloneta variegata* (Blackwall)**

CAV, KLK (3), LEI (3), LIM (37), **LOU**, **ROS**, **SLI**, TYR (13), **WAT**, **WES**.

***Porrhomma campbelli* F. O. P. -Cambridge**

COR (37), GAL (37), WIC (37).

***Porrhomma convexum* (Westring)**

COR (37), **SLI**.

***Porrhomma egeria* Simon**

KLD (5).

******Porrhomma montanum* Jackson**

CLA (27), DUB (27), WIC (26).

***Porrhomma oblitum* (O. P. -Cambridge)**

WES (12).

***Porrhomma pallidum* Jackson**

CAR (37), COR (5), DUB (37), FER (3), GAL (37), LAO (37), LIM (37), **LNF**, MAY (15), ROS (5), SLI (15), TIP (37), WEX (37), WIC (26).

***Porrhomma pygmaeum* (Blackwall)**

DUB, LEI (3), **LNF**, **LOU**, MON (5), ROS (3), WEX (25), WIC (37).

***Saaristoa abnormis* (Blackwall)**

CAV (5), DON (37), DUB (37), KLD (37), KLK (37), LAO (37), LEI (37), LIM (37), **LNF**, **ROS**, TIP (37), TYR (23), WAT (37), WEX (37).

***Saaristoa firma* (O. P. -Cambridge)**

ANT (14), ARM (14), CAV (5), CLA (37), COR (3), DUB (37), KER (37), KLD (37), KLK (37), LAO (37), **LEI**, LIM (37), **SLI**, TIP (37), WAT (37), WIC (37).

***Saloca diceros* (O. P. -Cambridge)**

CLA (5), COR (17), GAL (5), LIM (36), **MAY**, TIP (36).

***Satilatlas britteni* (Jackson)**

DON (36), KER (36), MAY (36), WAT (3).

***Savignia frontata* Blackwall**

DON (4), LEI (3), **LOU**, ROS (3), **TYR**, WIC (1).

***Silometopus ambiguus* (O. P. -Cambridge)**

COR (3).

***Silometopus elegans* (O. P. -Cambridge)**

ARM (23), CAV (5), COR (3), DON (4), GAL (37), KER (37), KLK (37), LAO (37), **LEI**, LIM (37), **LOU**, MAY (37), MON (5), OFF (10), SLI (3), WAT (37), WIC (26).

***Silometopus incurvatus* (O. P.-Cambridge)**

DON (5).

***Silometopus reussi* (Thorell)**

COR (3), KLD (1), **LIM**, **LNF**, WAT (3), WEX (1).

***Sintula corniger* (Blackwall)**

DER (14), GAL (5), TYR (14).

***Stemonyphantes lineatus* (L.)**

CAV, DON (4), FER (16), **KLK**, LEI (3), **LNF**, ROS (3), **WAT**.

***Tallusia experta* (O. P. -Cambridge)**

DON (4), DOW (23), FER (16), KLD (11), LEI (3), LIM (37), **LNF**, MAY (37), MON (5), OFF (10), **SLI**, WAT (3).

***Tapinocyba insecta* (L. Koch)**

ANT (16), COR (17), KLD (37), LEI (37), **MEA**, **ROS**, SLI (2), **WES**.

***Tapinocyba pallens* (O. P. -Cambridge)**

CAV, COR (3), DON (37), DUB (37), KER (17), LAO (37), LEI (3), **LNF**, **LOU**, **MEA**, **OFF**, **ROS**, SLI (2), TIP (5), TYR (5), WAT (2), **WES**, WIC (37).

***Tapinocyba praecox* (O. P. -Cambridge)**

COR, DON (5), **GAL**, **LEI**, LIM (37), MEA (5), WAT (3), WEX (25).

***Tapinopa longidens* (Wider)**

DON (4), **MON**, **SLI**.

***Taranucnus setosus* (O. P. -Cambridge)**

ANT (13), CLA (27), COR (39), DER (14), DON (15), DOW (13), DUB (37), FER (37), GAL (37), KLD (11), KLK (37), LAO (37), LEI (3), LIM (37), LNF (27), MAY (15), **ROS**, SLI (3), TIP (37), TYR (14), WAT (3), WES (12), WEX (25), WIC (37).

***Thyreosthenius parasiticus* (Westring)**

LEI (2), **MAY**, **MEA**, WAT (2), **WEX**.

***Tiso vagans* (Blackwall)**

DON (4), LAO (37), LEI (37), LIM (37), **LNF**, **MON**, OFF (10), WIC (37).

***Trichopterna thorelli* (Westring)**

COR (16), DON (4), GAL (37), MAY (37), OFF (10), **SLI**, WEX (25).

***Troxochrus scabriculus* (Westring)**

COR, DON (37), LAO (37), **OFF**, WAT (3).

***Troxochrus scabriculus* f. *cirrifrons* (O. P.-Cambridge)**

COR (3), WEX (25).

***Typhochrestus digitatus* (O. P. -Cambridge)**

DON (4), KLK (3), **SLI**.

***Walckenaeria acuminata* Blackwall**

LIM (37), **LNF**, ROS (5), SLI (37), TYR (5), WAT (37), WES (37), WEX (25), WIC (26).

******Walckenaeria alticeps* (Denis)**

OFF (32).

***Walckenaeria antica* (Wider)**

DON (4), FER (21), LEI (3), **LNF**, MEA (5), **MON**, ROS (5), WAT (3), WEX (25).

***Walckenaeria atrotibialis* (O. P. -Cambridge)**

CLA (37), DON (37), FER (16), GAL (6), KER (37), KLK (37), LAO (37), MAY (37), WAT (37), WIC (37).

***Walckenaeria clavicornis* (Emerton)**

CAV (5), DON (15), MAY (15), ROS (5), SLI (15).

***Walckenaeria cucullata* (C. L. Koch)**

GAL (5).

***Walckenaeria cuspidata* Blackwall**

ARM (23), **CAV**, COR (37), DER (16), DON (15), LEI (37), **LIM**, **LNF**, MAY (15), ROS (5), SLI (15), WAT (37), WIC (26).

******Walckenaeria dysderoides* (Wider)**

CAR (37), CLA (37), COR (37), DUB (37), GAL (7), KER (37), SLI (3), TIP (37), WAT (37), WEX (37), WIC (37).

***Walckenaeria kochi* (O. P. -Cambridge)**

ARM (23), CLA (37), DON (37).

***Walckenaeria nodosa* O. P. -Cambridge**

ANT (16), CAR (37), COR (3), DON (4), KER (37), KLD (30), LEI (3), LIM (37), MAY (37), ROS (3), SLI (3).

***Walckenaeria nudipalpis* (Westring)**

CLA (37), COR (17), DON (4), FER (21), GAL (37), **KLK**, LAO (37), LIM (37), SLI (15), TIP (37), WAT (37), WES (37), WEX (25), WIC (26).

***Walckenaeria unicornis* O. P. -Cambridge**

ANT (16), DON (4), FER (37), LEI (37), LIM (37), **LNF**, **LOU**, MAY (37), MEA (5), MON (5), OFF (37), **ROS**, SLI (3), WAT (3), WIC (37).

***Walckenaeria vigilax* (Blackwall)**

CAR (37), COR (37), KER (37), KLK (37), LAO (37), LEI (3), LIM (37), MAY (37), OFF (37), **SLI**, TIP (37), WAT (37), WES (37), WEX (25), WIC (37).

TETRAGNATHIDAE

***Metellina mengei* (Blackwall)**

ANT (13), ARM (14), CAR (37), CAV (5), **DER**, DUB (37), KLK (3), **LEI**, LIM (37), **LNF**, **LOU**, **MAY**, MEA (5), **MON**, WAT (37), WES (12), WEX (25).

***Metellina merianae* (Scopoli)**

LIM (37), **LOU**, **MEA**, **MON**, WEX (25).

***Metellina segmentata* (Clerck)**

CAV, DON (5), KLD (30), KLK (37), LAO (37), LIM (37), **LNF**, **MON**, ROS (5), TIP (37), WAT (35), WEX (25).

***Pachygnatha clercki* Sundevall**

TYR (23).

***Pachygnatha degeeri* Sundevall**

CAV, LEI (37), LIM (37), **LNF**, MEA (1).

***Pachygnatha listeri* Sundevall**

COR (17), WES (5).

***Tetragnatha extensa* (L.)**

CAV (5), **MEA**, MON (5).

***Tetragnatha montana* Simon**

CAV (5), GAL (5), LIM (37), LOU (5), **MON**, **MEA**.

***Tetragnatha nigrita* Lendl**

GAL (5), SLI (3), **TIP**.

***Tetragnatha obtusa* C. L. Koch**

ANT (16).

ARANEIDAE

***Agalenatea redii* (Scopoli)**

LEI (3), **LNF**, LOU (5), **SLI**, **TIP**.

***Araneus diadematus* Clerck**

MON.

***Araneus quadratus* Clerck**

ARM (14), FER (13), LEI (3), **LNF**, MON (5), **WEX**.

***Araneus sturmi* (Hahn)**

KER (2).

***Araniella cucurbitina* (Clerck)**

KLK (3), SLI (3).

***Araniella opisthographa* (Kulczyński)**

GAL (37), TIP (37), TYR (16), **WAT**, **WEX**.

***Cyclosa conica* (Pallas)**

CAV, **DUB**, KLK (5), **MON**, **WES**.

***Gibbaranea gibbosa* (Walckenaer)**

ANT (16), TYR (16).

***Hypsosinga albovittata* (Westring)**

KLD (29), OFF (29).

***Hypsosinga pygmaea* (Sundevall)**

DON (37), **LNF**.

***Larinioides cornutus* (Clerck)**

LAO, **MEA**, **MON**, TYR (16).

***Larinioides sclopetarius* (Clerck)**

CLA (5), GAL (27), KLD (5), **KLK**, LEI (3), LIM (5), **LNF**, OFF (5), SLI (5), TIP (2).

***Nuctenea umbratica* (Clerck)**

CAV, **DON**, **DUB**, **LIM**, **MEA**, **MON**, OFF (41), **WAT**, **WEX**.

***Zygiella atrica* (C. L. Koch)**

LNF, SLI (20), **WAT**.

***Zygiella x-notata* (Clerck)**

CAV, **LAO**, **LEI**, **MON**, **ROS**, **SLI**.

LYCOSIDAE

***Alopecosa barbipes* (Sundevall)**

DOW (16).

***Alopecosa cuneata* (Clerck)**

WEX (25).

***Alopecosa pulverulenta* (Clerck)**

DER (20), KLK (37), LAO (37), LEI (37), MEA (5), SLI (15), WES (37), WEX (25).

***Arctosa leopardus* (Sundevall)**

ARM (23), KLD (30), OFF (10).

***Arctosa perita* (Latreille)**

LAO (37).

****Pardosa agrestis* (Westring)**

TIP (37), WEX (25).

***Pardosa agricola* (Thorell)**

COR, **SLI**, TIP (37), **WAT**.

***Pardosa amentata* (Clerck)**

KLK (37), **LNF**, MEA (1).

***Pardosa monticola* (Clerck)**

FER (16), MEA (5), **SLI**, WEX (25).

***Pardosa nigriceps* (Thorell)**

ARM (23), **CAV**, KLD (11), LAO (37), LIM (37), **LOU**, WAT (3), WES (37).

***Pardosa palustris* (L.)**

KLD (1), KLK (37), LAO (37), LIM (37), MEA (1), OFF (10), **SLI**, TYR (23), WAT (37), WEX (25).

***Pardosa prativaga* (L. Koch)**

COR (5), WAT (3), WEX (5), WIC (5).

***Pardosa pullata* (Clerck)**

KLK (3), LEI (3), **LNF**, MEA (5), **MON**, **ROS**, WEX (25).

***Pardosa purbeckensis* F. O. P. -Cambridge**

COR (2), WAT (2), WEX (5).

***Pardosa saltans* Töpfer-Hofmann**

CAV (5), GAL (5).

***Pirata hygrophilus* Thorell**

CAV (5), MAY (42), OFF (10), WAT (37), WES (12).

***Pirata latitans* (Blackwall)**

CLA (37), GAL (37), LAO (37), LIM (37), OFF (10).

***Pirata piraticus* (Clerck)**

MEA, WAT (3).

***Pirata piscatorius* (Clerck)**

ANT (23), DOW (23), TYR (23), WES (12).

****Pirata tenuitarsis* Simon**

KLD (11), MAY (42).

***Pirata uliginosus* (Thorell)**

COR (37), DON (37), GAL (37), KER (37), LAO (37), LEI (3), LIM (37), MAY (37), WAT (37), WES (37), WIC (37).

***Trochosa ruricola* (De Geer)**

MEA (1).

***Trochosa spinipalpis* (F. O. P. -Cambridge)**

ARM (23), CLA (37), COR (37), DOW (23), DUB (37), GAL (37), KER (37), KLD (11), KLK (37), LAO (37), LEI (37), **LOU**, OFF (10), **SLI**, TIP (37), TYR (23), WAT (37), WIC (37).

***Trochosa terricola* Thorell**

LAO (37), LEI (37), MEA (5).

PISAURIDAE

***Dolomedes fimbriatus* (Clerck)**

LEI (3), LIM (37), **LNF**.

***Pisaura mirabilis* (Clerck)**

CAV, LAO (37), LEI (37), **LIM**, **LNF**, LOU (5), **MON**, **SLI**, **WES**.

AGELENIDAE

***Agelena labyrinthica* (Clerck)**

KLD (30), **LAO**, **LIM**, **MEA**.

******Tegenaria agrestis* **(Walckenaer)**

COR (2), WEX (5).

***Tegenaria atrica* C. L. Koch**

MEA.

***Tegenaria domestica* (Clerck)**

ROS.

***Tegenaria parietina* (Fourcroy)**

COR (2).

***Tegenaria saeva* Blackwall**

DON, **LIM**, **SLI**, WAT (2).

******Tegenaria silvestris* **L. Koch**

COR (3).

***Textrix denticulata* (Olivier)**

MEA, **WAT**.

CYBAEIDAE

***Argyroneta aquatica* (Clerck)**

DON, **FER**, **KER**, **LEI**, **LIM**, **LNF**.

HAHNIIDAE

***Antistea elegans* (Blackwall)**

ARM (23), CAV (5), COR (3), DON (37), DOW (23), LEI (3), LIM (37), LOU (5), MON (5), **SLI**, WAT (3), WES (12), WEX (25).

***Hahnia helveola* Simon**

CAV (5), COR (17), DON (4), GAL (5), KLD (30), SLI (3), WAT (2), **WES**.

***Hahnia montana* (Blackwall)**

CAV, **DER**, **LEI**, **LIM**, **LNF**, ROS (5), **SLI**, **WEX**, WIC (37).

***Hahnia nava* (Blackwall)**

COR (37), DON (5), LIM (37), **LNF**, MEA (5), **WEX**.

DICTYNIDAE

***Argenna subnigra* (O. P. -Cambridge)**

MEA (5).

***Cryphoeca silvicola* (C. L. Koch)**

CAV (5), COR (37), DON (37), **KLD**, **KLK**, LAO (37), LIM (37), **LNF**, **LOU**, **MEA**, **MON**, OFF (37), **ROS**, **SLI**, **TYR**, **WAT**, **WEX**.

***Dictyna arundinacea* (L.)**

CAV (5), LEI (3), **LNF**, LOU (5), **SLI**.

***Dictyna latens* (Fabricius)**

KLK (3), **WAT**.

***Dictyna uncinata* Thorell**

CAR (16).

****Lathys* sp.**

KLK (5), WAT (5).

***Nigma puella* (Simon)**

COR (3), GAL (5), KER (36), KLK (3), LIM (5), TIP (2), WAT (3), WEX (2).

AMAUROBIIDAE

***Amaurobius fenestralis* (Stroem)**

KLD, **LEI**, **LIM**, **ROS**, WAT (35).

***Amaurobius ferox* (Walckenaer)**

CAV, **MON**, **ROS**, **WAT**, **WES**.

***Amaurobius similis* (Blackwall)**

MON, **WAT**.

ANYPHAENIDAE

***Anyphaena accentuata* (Walckenaer)**

CAV (5), **KLD**, **LAO**, **LEI**, **LNF**, **MON**, **SLI**, **TIP**, **TYR**, **WES**, **WEX**.

LIOCRANIDAE

***Agroeca proxima* (O. P. -Cambridge)**

ARM (23), COR (37), DON (4), FER (21), KER (37), KLD (30), MAY (37), WEX (25), WIC (26).

***Liocranum rupicola* (Walckenaer)**

GAL (5), WEX (2).

***Phrurolithus festivus* (C. L. Koch)**

ANT (16), CAR (16), **MAY**, **WAT**, **WEX**.

***Scotina celans* (Blackwall)**

COR (2), GAL (5), **LIM**, **LNF**, **OFF**, SLI (3), **WES**.

***Scotina gracilipes* (Blackwall)**

DER (14), FER (16), KLD (30), LEI (3), **LIM**, LOU (5), TYR (14).

CLUBIONIDAE

***Cheiracanthium erraticum* (Walckenaer)**

MAY.

***Clubiona brevipes* Blackwall**

TIP (37).

***Clubiona comta* C. L. Koch**

CAV, COR (37), **KLD**, KLK (3), LEI (37), LIM (37), **LNF**, **LOU**, **MAY**, **MEA**, **MON**, OFF (37), **SLI**, **TYR**, **WES**.

***Clubiona diversa* O. P. -Cambridge**

DON (5), **LEI**, **LNF**, MEA (5), **ROS**, TIP (37), WIC (37).

******Clubiona frutetorum* L. Koch**

GAL (6).

***Clubiona lutescens* Westring**

CAV, GAL (5), KLK (37), **LIM**, **LOU**, **MON**, TIP (37), WAT (3), **WIC**.

***Clubiona neglecta* O. P. -Cambridge**

FER (13), KLD (30), **LIM**, **LOU**, OFF (10), WEX (25).

***Clubiona pallidula* (Clerck)**

GAL.

***Clubiona phragmitis* C. L. Koch**

LNF, MEA (5), MON (5), **SLI**, WAT (3).

***Clubiona reclusa* O. P. -Cambridge**

CAV (5), KLK (3), **MON**, TYR (14).

***Clubiona stagnatilis* Kulczyński**

ARM (23), DON (5), DOW (23), KLD (11), **LOU**, MON (5), SLI (3), WEX (25).

***Clubiona subtilis* L. Koch**

COR (2), **DUB**, **LOU**, MEA (5), **WAT**, WEX (25).

***Clubiona terrestris* Westring**

KLD, **LAO**, MEA (5), **MON**, **SLI**.

***Clubiona trivialis* C. L. Koch**

CAV (5), CLA (37), KER (37), KLD (30), LEI (3), LIM (37), **LNF**, LOU (5), MAY (37), **SLI**, TIP (37), **TYR**, WAT (3), **WEX**.

GNAPHOSIDAE

***Drassodes cupreus* (Blackwall)**

CAV, DOW (19), FER (16), KLK (3), MEA (5), **SLI**, **TIP**, WAT (37), WEX (25).

***Drassodes lapidosus* (Walckenaer)**

FER (16), GAL (5), KER (16), KLK (37), **WAT**, **WEX**.

The status of *D. lapidosus* / *cupreus* in Ireland requires a review. On present evidence, it appears that many published records for *lapidosus* refer to *D. cupreus*. Pending a complete review, I have assumed that the records for *D. cupreus* listed by Helsdingen (1996a) are correct. However I have also included records for the much scarer *D. lapidosus*, based on recently determined material.

***Drassodes pubescens* (Thorell)**

WES (34).

***Drassyllus lutetianus* (L. Koch)**

KER (36).

***Drassyllus pusillus* (C. L. Koch)**

LNF, OFF (10), WEX (25).

***Haplodrassus signifer* (C. L. Koch)**

COR (37), DON (4), FER (16), LEI (3), **LNF**, WAT (3).

***Micaria pulicaria* (Sundevall)**

CAV (5), **KLK**, LAO (37), **LEI**, **LIM**, **LNF**, MEA (5), **ROS**, **SLI**, WAT (3).

***Scotophaeus blackwalli* (Thorell)**

SLI.

***Zelotes apricorum* (L. Koch)**

DON (4), KER (3).

***Zelotes electus* (C. L. Koch)**

WEX (25).

***Zelotes latreillei* (Simon)**

ARM (13), GAL (5), **KLK**, MEA (5), **SLI**.

ZORIDAE

***Zora spinimana* (Sundevall)**

ARM (23), LAO (37), LEI (3), **LIM**, LOU (5), **MEA**, **SLI**, WAT (37), **WES**, **WEX**.

PHILODROMIDAE

******Philodromus albidus* **Kulczyński**

COR (5), GAL (5), **SLI**.

***Philodromus aureolus* (Clerck)**

COR (3), **MON**, **SLI**, **WAT**, WES (12).

***Philodromus cespitum* (Walckenaer)**

CAV, KLK (3), LEI (3), **LOU**, TIP (37), **WAT**, WEX (25).

***Philodromus dispar* Walckenaer**

DUB (27), GAL (5), KLK (5), TIP (5).

******Philodromus praedatus* **O. P. -Cambridge**

CAV (5), GAL (5).

***Tibellus maritimus* (Menge)**

ANT (16), COR (37), KLD (11), LAO (37), **MEA**, MON (5), **SLI**, TYR (16), WAT (37), WES (12), **WEX**.

***Tibellus oblongus* (Walckenaer)**

COR (1), FER (16), LEI (3), **LOU**, MAY (37), SLI (3), **TIP**.

THOMISIDAE

******Diaea dorsata* **(Fabricius)**

KER (2), WEX (5).

***Misumena vatia* (Clerck)**

DUB, WES (12).

***Ozyptila atomaria* (Panzer)**

ARM (13), **COR**, DON (4), FER (16), ROS (5), **SLI**.

***Ozyptila brevipes* (Hahn)**

COR (3), **WIC**.

***Ozyptila sanctuaria* (O. P. -Cambridge)**

COR (3), KLK (2), MEA (5).

***Ozyptila trux* (Blackwall)**

KLD (11), KLK (37), LEI (3), LIM (37), **LNF**, **MEA**, **ROS**, SLI (3), TYR (19), WES (12).

***Xysticus cristatus* (Clerck)**

KLK (5), **LNF**, **MON**, **WES**.

***Xysticus erraticus* (Blackwall)**

ANT (21), DON (5), FER (16), KLD (11), MEA (5), **SLI**, WEX (25).

***Xysticus sabulosus* (Hahn)**

ANT (21), ARM (13), DER (13).

***Xysticus ulmi* (Hahn)**

KER (37), TIP (5).

SALTICIDAE

***Euophrys frontalis* (Walckenaer)**

CAR (16), KLK (3), WAT (3), WEX (25).

***Heliophanus cupreus* (Walckenaer)**

CAR (16), **SLI**, **WEX**.

***Heliophanus flavipes* (Hahn)**

COR, DON (4), KLD (30), **KLK**.

***Neon reticulatus* (Blackwall)**

CAV, **CLA**, COR (37), DOW (14), LEI (3), **LNF**, **ROS**, **WAT**, WES (12).

******Neon robustus* **Lohmander**

WIC (40).

***Pseudeuophrys erratica* (Walckenaer)**

WAT.

***Pseudeuophrys lanigera* (Simon)**

COR (2), LAO (5), SLI (2).

***Salticus scenicus* (Clerck)**

DER (20), **DON**, **MON**, **SLI**, **TIP**, **WAT**, **WES**.

***Sitticus caricis* (Westring)**

WES (12).

Discussion

Altogether, 5881 Irish county records for spiders have now been accumulated, representing a 67% increase on the total summarised by Helsdingen (1996a). The average number of spider species recorded per county is now 184, with the actual totals listed on Table 1. Much of the variation in county totals is likely to be due to the unequal recording effort, although southern and coastal counties are clearly expected to have the most diverse spider faunas. A large number of new county records have been accumulated for some species, notably *M. herbigradus* (+21), *P. juncea* (+21) and *T. setosus* (+24). On the other hand it is surprising that there are no new county records for some species, including *Lepthyphantes leprosus* (Ohlert), *Larinioides patagiatus* (Clerck), *Ozyptila praticola* (C. L. Koch) and *Evarcha falcata* (Clerck). With over 410 spiders now reported from Ireland, it is evident that plenty of scope remains for the accumulation of additional county records.

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TABLE 1. Summary of Irish county records for spiders.

Antrim	192+21 = 213	Leitrim	34+128 = 162
Armagh	99+37 = 136	Limerick	53+123 = 176
Carlow	200+20 = 220	Longford	23+94 = 117
Cavan	50+84 = 134	Louth	55+59 = 114
Clare	216+29 = 245	Mayo	118+62 = 180
Cork	151+113 = 264	Meath	44+81 = 125
Derry	107+24 = 131	Monaghan	46+71 = 117
Donegal	97+99 = 196	Offaly	96+64 = 160
Down	159+25 = 184	Roscommon	77+70 = 147
Dublin	196+38 = 234	Sligo	68+145 = 213
Fermanagh	142+55 = 197	Tipperary	137+65 = 202
Galway	188+65 = 253	Tyrone	48+67 = 115
Kerry	204+59 = 263	Waterford	87+147 = 234
Kildare	113+76 = 189	Westmeath	71+78 = 149
Kilkenny	93+87 = 180	Wexford	113+112 = 225
Laois	99+79 = 178	Wicklow	151+77 = 228

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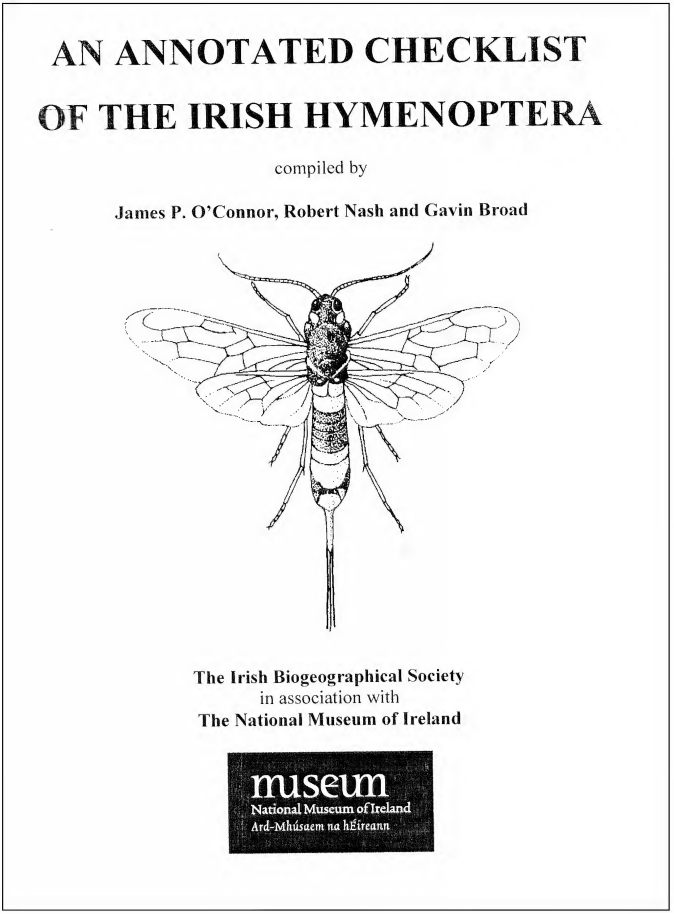

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